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ABSTRACT

Following a review of the literature on responses of autistic persons to environmental stimulation, three experiments are detailed which examine the relationship between modality preference and rate of acquisition of a discrimination task. First, seven autistic children's preference for colored lights and/or simple tones was assessed in a sensory conflict situation (i.e., there was opportunity to respond to either light or tone). In Experiment 2, stimuli were incorporated into a simple serial discrimination task to determine whether stimulus preference was related to the speed at which children learn a discrimination. In the final experiment, the transfer to a school related material was explored. Results are detailed for each S. Among implications reviewed are the importance of developing appropriate assessment techniques for stimulus preferences of lower functioning children and the difficulty of assigning autistic students to homogeneous groups. (CL)

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FINAL REPORT

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Modality Preferences in Autistic Children: Assessment and Relationship to Discrimination Learning

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CHAPTER I

INTRODUCTION

Over the past two decades, a plethora of research has been conducted in the area of perceptual-cognitive deficits in autistic children (see Litrownik & McInnis, 1980). Several groups of researchers, e.g., Lovaas and his colleagues (Lovaas, Schreibman, Koegel, & Rehm, 1971), Ornitz and Ritvo (1968), Rimland (1964), Hermelin and O'Connor (1970), Rutter (1974), and Wing (1976) have speculated that one of the primary factors in the etiology of early infantile autism is the inability to integrate and intelligently organize information present in the environment. It has also been suggested that this "basic perceptual-cognitive dysfunction" is responsible for other abnormalities or deficits observed within the autistic population, e.g., failure to (1) develop social behavior, (2) learn observationally, (3) develop communicative skills, and (4) transfer behavior learned in one environment to other new environments (Lovaas, Koegel, & Schreibman, 1979; Rutter, 1974).

Much of the research on perceptual-cognitive deficits came about as a result of clinical observations of autistic children in the fifties and sixties. It was noted that from the first days of life these children did not respond normally to environmental stimulation (see Ornitz & Ritvo, 1968). They were often

thought to be deaf or blind due to their apparent indifference to sensory stimulation, even in the absence of sensory impairment. What is more, many of the children showed drastic inconsistencies in their response to one type of input over time. For example, prolonged preoccupation with sounds (i.e., attention to self-induced sounds) could be replaced by heightened irritability to sound (i.e., unusual fear of noise), or by total nonresponsiveness to sound (i.e., lack of startle response to loud noise) (Ornitz & Ritvo, 1968).

Several theories have been postulated in an attempt to account for these abberant responses to environmental stimulation. Researchers who have focused on the learning characteristics of autistic children under varying conditions of sensory stimulation have proposed that autistic children evidence (1) an abnormal modality preference (Hermelin & O'Connor, 1964), (2) an inability to code information (Hermelin, 1976), and (3) overselective attention (Lovaas, Schreibman, Koegel, & Rehm, 1971). These groups do not deny the possible effects of genetic, biochemical, or neurological factors, but they do believe that we can understand autism as well as develop appropriate remedial techniques based on systematic behavioral research. Those who have focused on physiological activity in autistic children argue that these children are (1) underaroused (Rimland, 1964), (2) overaroused (Hutt, Hutt, Lee, & Ounsted, 1964), or (3) exhibit faulty modulation of input (i.e., perceptual inconstancy) (Ornitz & Ritvo, 1968). Though

these purported dysfunctions have stimulated a good deal of research, they have not led to the development of effective intervention strategies with autistic children (Gersten, 1980).

The purpose of the present paper is twofold. First, I will examine the most prominent explanatory theories and attempt to determine their implications for educating autistic children. Because I am mainly concerned with the development of alternative teaching strategies for autistic children, I will limit my discussion to the findings of studies based on systematic behavioral research. While it is beyond the scope of this paper to include all of the explanatory theories that emphasize dysfunctions, periodic reference will be made to this material when it is related to remedial techniques and/or approaches. For a more comprehensive review of this literature the reader is referred to Litrownik and McInnis (1980).

In the second portion of this paper, I will present the results of a series of experiments, conducted in our laboratory, which were designed to expand on the available information regarding abnormal modality preference in autistic children, and its relationship to the effectiveness of various instructional strategies (i.e., utilizing modality strengths).

CHAPTER II

LITERATURE REVIEW

Abnormal Modality Preference

Goldfarb (1956) was one of the first clinicians to take note of what seemed to be a distortion in the hierarchy of receptor preferences in psychotic children. Both he and Schopler (1965) remarked that unlike normal children, schizophrenic children failed to make the transition from proximal (taste, touch, smell) to distal (sight, hearing) receptor usage in the course of their development. They typically manipulated objects in the environment by prolonged touching, tasting, or smelling, and showed marked difficulty in fixating visually for long periods of time. Similarly, they did not seem to respond to auditory stimulation in the manner typical of normal children.

While Goldfarb found no apparent dysfunction in visual or auditory acuity or thresholds of his subjects, they did appear to exhibit visual and auditory avoidance or inattention. Although they could see and hear, they did not seem to look or listen. Goldfarb claimed that use of the distance senses cannot be separated from the functions of attention and volition. He concluded that schizophrenic children actively choose to fragment their perceptual experience by selectively responding to certain portions of the world and not to others.

In an attempt to validate the theory of receptor dominance, Hermelin and O'Connor (1964) conducted a series of experiments involving a sensory conflict paradigm. Light, sound, and touch stimuli were simultaneously presented in pairs, and the children were required to point to the source of one of the presented stimuli. When pointing to either stimulus in the pair was reinforced, both autistic and retarded children responded most frequently to light in preference to sound or touch. However, when sound and touch were paired, the autistic children responded more frequently to touch, while the retarded children responded most frequently to sound. The authors concluded that while a hierarchical dominance of the visual system had developed in both autistic and retarded children, the pattern of preferential pointing to sound and touch indicated differential effects of sensory input for the two groups.

One of the methodological considerations of the above study was the lack of control for relative intensity of the visual and auditory stimuli. In an attempt to correct for this discrepancy, O'Connor and Hermelin (1965) presented pairs of light, tone, or the words "Come here" in varying intensities to autistic, Down's syndrome, and non-Down's syndrome retarded children. They found that all of the children tended to respond to the more intense of the two simultaneously-presented stimuli, regardless of modality. When light and tone were presented together, the

retarded children predominantly responded to light. The autistic children responded to light only one-half of the time, and then mostly to high intensity light. All of the children evidenced fewer responses to light when words were presented, but this difference was only significant in the non-Down's retarded group. It was suggested that the results of the previous study (Hermelin & O'Connor, 1964) may have been due to a relatively higher intensity of light than sound. The authors did conclude that the results of this study supported the claim that a sensory hierarchy is sufficiently developed in autistic children.

Metz (1967) provided support for the notion that autistic children prefer high intensity stimuli. Normal, schizophrenic, and autistic children were permitted to adjust the volume levels for various types of recorded material. Results indicated that while autistic children selected higher volume settings than controls, the schizophrenic children did not differ from normals in volume choice. Metz suggested that efforts be made to increase the level of environmental stimulation for autistic children in order to make a greater impact on them. This is consistent with the theory of underarousal proposed by Rimland (1964).

In another sensory conflict experiment, Schopler (1966) examined visual and tactile preferences in normal children of various ages, schizophrenic children, and retarded children. He found that (1) normal children show a developmental tendency

for increased visual preference with increased age, and (2) they do not show a corresponding decrease in tactile preference. All three groups spent equivalent amounts of time on tactual exploration, but schizophrenic children scored significantly lower than normals on all visual measures. Thus, while support was given to the hypothesis that psychotic children respond less to visual stimulation than normals, the general notion of a hierarchy of receptor preferences in the development of normal children was not upheld.

It is important to note that in the early studies described by Goldfarb (1956) and Schopler (1965, 1966), there is considerable ambiguity regarding the homogeneity of their psychotic groups. In many cases, the label "schizophrenic" included those children who exhibited autistic-like symptoms. Whether the subjects were truly autistic cannot be determined from the descriptive data provided by the authors. Similarly, where efforts were made to provide IQs and mental ages of the subjects, these ranged widely and suggest that the children varied dramatically in level of functioning. Hermelin and O'Connor (1964) and O'Connor and Hermelin (1965) were careful to match their subjects on chronological age, sex, and, as far as possible, IQ. However, in the latter experiment (O'Connor & Hermelin, 1965), where some verbal comprehension was required (i.e., to understand the words "Come here"), the subjects were not matched for verbal mental ages.

The non-Down's syndrome retarded children had significantly higher verbal mental ages than the other two groups, and it was they who responded significantly more to the command "Come here."

When all of these factors are considered, it is difficult to determine whether autistic children do indeed exhibit abnormal modality preferences. While they were often observed to be preoccupied with the proximal senses, the theory of sensory dominance could not explain their periodic lack of responsiveness to cold, heat, or pain (Hermelin & O'Connor, 1970). Hermelin and O'Connor (1970) speculated that a number of other factors may contribute to the apparent abnormal responses of autistic children to sensory stimulation, e.g., (1) the role of interest and motivation, (2) the level of arousal, (3) the relationship between low verbal ability and perceptual impairment, and (4) the interpretation and/or integration of information from different sensory systems. As evidence has emerged to refute the notion of a hierarchy of receptor preferences in the development of normal children (Rock & Harris, 1967), research in the area of sensory dominance in autism has all but been abandoned in favor of theories of inadequate coding or overselective attention. As a result, no attempt has been made to utilize the information derived from the above studies for the development of new teaching strategies in educational settings.

Information Processing: Inability to Code Information

Beate Hermelin and her colleagues in Great Britain have provided one of the most impressive bodies of research in the area of perceptual-cognitive deficits in autistic children. Based on the results of a series of discrimination learning studies carried out in the late sixties and early seventies, they have argued that the primary deficiency in autism centers around faulty mediation of sensory input at the coding level of information processing (Hermelin & O'Connor, 1970). Evidence has been gathered to show that autistic children are unable to use visual cues to ameliorate their performance in perceptual motor tasks (DeMyer, 1971; Frith & Hermelin, 1969; Hermelin & O'Connor, 1966, 1970). While examination of eye movements in these children does not show visual avoidance (Hermelin & O'Connor, 1967), it appears that they spend less time looking at visual stimuli than normal children and assign little meaning to these visual signs (O'Connor, 1971). Hermelin and O'Connor (1970) concluded that the ability to successfully integrate and intercorrelate input and output data is absent in autistic children, and this deficiency might be responsible for their abnormal responses to sensory stimulation.

To further develop this theory, Frith and Hermelin (1969) attempted to examine selected aspects of information processing in autistic children. They had previously established that these children seemed less impaired when learning spatially-oriented

taska and receiving feedback from their own response movements (Hermelin & O'Connor, 1967). However, this type of task required little coding or retention of information. Efforts were then made to determine how the children would respond to material presented within a temporal framework. How would they handle patterns of visual and auditory input, presented serially, which exceeded the limits of their short-term memory capabilities?

Hermelin and her colleagues found that both with visual (Frith & Hermelin, 1969) and auditory (Hermelin & O'Connor, 1967) sequences, autistic children treated the material as a series of distinct items to be retained by rote memory. Unlike normal children, they seemed to make no effort to condense the information into categories or chunks of related material. The authors concluded that autistic children are unable to recognize redundancies and rules, and, as a result, cannot reduce their information loads to enable them to integrate stimuli and interpret their environment (Hermelin, 1976). Hermelin (1976) has suggested that the impairment of this process may underlie much of the cognitive pathology of autism.

Hermelin (1976) and O'Connor (1971) have cautioned that the results of their experiments are tentative and can only be generalized to autistic children of similar mental ages as those described in their studies. In addition, they have found that autistic children at higher levels of functioning often perform

significantly better than retarded children or lower functioning autistic children. It is difficult, then, to determine to what extent the results of these researchers can be generalized to the population of autistic children. As a result, Hermelin and her colleagues have as yet made no attempt to apply the information they have provided.

Fyffe and Prior (1978) have recently called into question the results and conclusions of Hermelin and O'Connor (1967), and Hermelin (1976). In a careful replication of Hermelin and O'Connor (1967), and correcting what they described as severe methodological problems, Fyffe and Prior found that autistic children can actively reorganize material and appreciate structure in sentences. They concluded that, at present, there is insufficient evidence from verbal recall studies to maintain the hypothesis of deficiencies in the recognition of redundancies and rules in sequentially-presented material. They claim that it is retarded development, and not a specific dysfunction in coding which may be responsible for the inferior performance of autistic children in this type of task. They suggest that further replication of the available research is necessary before any generalizations may be made concerning information processing in autistic children.

Overselective Attention

The proponents of sensory dominance and information-processing theories provided important information concerning selective aspects of perceptual cognitive functioning in autistic children. However, neither theory attempted to account for the puzzling observation that these children often respond differentially to the same sensory input over time. A similar phenomenon was found in other psychotic groups, and researchers working with adult schizophrenics (see Buss & Lang, 1965; Lang & Buss, 1965) had come to the conclusion that this "deficit" was primarily one of "selective attention." These authors claimed that schizophrenics were most impaired when required to pay attention to more than one stimulus input at a time or switch their attention from one stimulus to another.

The notion of selective attention has received considerable support in recent years and has proven to be a promising area of research with autistic children. Lovaas, Schreibman, Koegel, and Rehm (1971), in what has become a classic experiment, were the first to point out that autistic children are overselective in their responding to multiple cues in a stimulus complex. Autistic, retarded, and normal children were trained to press a bar for food when presented with a stimulus complex of light, tone, and a pressure on the leg. Each component of the complex (i.e., light, sound, and touch) was then presented singly, in

order to determine which aspects of the complex the children were responding to. It was found that while normal children pressed the bar equally for all three components, the retarded children typically responded to only two of the components, and the autistics to one. Similar results were found when two stimuli were used in the complex (Lovaas, Schreibman, Koegel, & Rehm, 1971). Lovaas and his colleagues labeled the phenomenon stimulus overselectivity and suggested that it may play an essential role in the etiology of autism. That is, it could be responsible for other problems observed within the syndrome (e.g., failure to develop language and social behavior, inability to learn observationally, inability to generalize information gained from training within a controlled setting to the outside world) (Lovaas et al., 1979). Schreibman (1975) claimed that because these children are under restricted stimulus control, efforts should be made to insure a restricted educational environment with the provision of only those stimuli relevant to the task they are learning. Lovaas et al. (1979) implied that if stimulus overselectivity can be eliminated, autistic children may be more able to respond to the environment in a normal manner.

Despite the large amount of data which has been amassed in support of the overselectivity theory, the conclusions of Lovaas et al. (1979) have been called into question by a number of researchers (Gersten, 1980; Litrownik, McInnis, Wetzel-Pritchard, & Filipelli, 1978; Ross, 1976; Schover & Newsom, 1976). Perhaps

what has been considered the major methodological problem with this brand of research has been the failure of its originators to equate their groups on age, intellectual ability, and language skills. This is particularly important because overselective attention has not been found in some high functioning autistic children (Schover & Newsom, 1976), and has been found in some retarded children (Litrownik et al., 1978) and in young normal children (Eimas, 1969). Ross (1976) stated that overselective attention can be identified in many but not all autistic and moderately to severely retarded children, and may be a reflection of a general cognitive delay. On the basis of their findings, Schover and Newsom (1976) also speculated that breadth of learning increases as cognitive functioning improves. Lovaas et al. (1979) have acknowledged that the role of intellectual functioning as related to overselectivity must be further examined before conclusions may be made regarding its role in the etiology of autism.

Another consideration of stimulus overselectivity is that it has been observed only in a redundant relevant cue paradigm (e.g., simultaneous and serial discrimination tasks with subsequent component test trials). Litrownik et al. (1978) pointed out that the role of retention (i.e., memory) may have played a part in the results obtained by Lovaas and his research group. In a simultaneous match-to-sample task, and matching subjects on

mental age, Litrownik et al. (1978) found that only retarded children evidenced restricted responding to a stimulus complex. They speculated that while autistic children may process multiple cues initially, they may select a limited number of dimensions to respond to when a complex stimulus consisting of redundant relevant cues is presented over a number of trials. They suggest that autistic children may evidence restricted stimulus control and not limited attention.

One significant outcome of the overselectivity research has been the direct application of the experimental results to the development of new teaching procedures (Gersten, 1980). Schreibman (1975) and Rincover (1978) described the successful use of within-stimulus prompts to facilitate learning in autistic children. In this procedure children were first taught to respond to an exaggerated feature of the discriminative stimulus. This feature was then faded gradually over a number of trials. If the children continued to respond to the discriminative stimulus after the prompt was faded to its original size, the task was considered learned. In this way the children were permitted to remain over-selective, yet able to learn new material.

In his reevaluation of Schreibman's (1975) data, Gersten revealed that conventional teaching procedures worked in 42% of her cases, and neither conventional nor within-stimulus prompt procedures worked in 8% of her cases. Similarly, Richter (1979) failed to replicate the findings of Rincover (1978). At present,

we can only speculate that this method may be effective with certain children in certain specific instances (Gersten, 1980).

An alternative approach to within-stimulus prompts is one which assumes that stimulus overselectivity is not a permanent feature of autism, and can be reversed with "overtraining." Schover and Newsom (1976) overtrained autistic children to broaden their responding to multiple cues. Schaeffer, Kollinzas, Musil, and McDowell (1977) employed overtraining to auditory stimuli in addition to regular manual sign training to facilitate the acquisition of speech in mute autistic children. Whether stimulus overselectivity is a result of a developmental delay or a specific dysfunction in perceptual-cognitive processing, the use of overtraining appears to have promising implications for future educational programming.

Summary

Although a plethora of research has been generated in the area of perceptual-cognitive deficits in autism, much of the evidence regarding the etiology of this syndrome remains inconclusive, and in need of further substantiation. According to Litrownik and McInnis (1980), part of the problem may be attributed to the fact that researchers have chosen to focus on specific functions (i.e., abnormal modality preference, overselective attention), and have not related the results to what we do know about perceptual-cognitive processing in other

populations. As a result, the tenuous nature of the available data has, for the most part, precluded their application to educational settings. In summary, researchers have as yet made little progress in helping to develop new teaching strategies to compensate for perceptual-cognitive deficits in autistic children.

While the literature reviewed up until now has focused mainly on learning characteristics of autistic children, it is important to note that a similar state of underdevelopment pervades the work of those who have focused on physiological activity in these children. Conflicting reports that autistic children are physiologically underaroused (Rimland, 1964), or overaroused (Hutt et al., 1964) have led to the suggestions that the learning environments of these children should be systematically controlled by increasing (see Metz, 1967), or decreasing (see Schreibman, 1975) levels of sensory stimulation. While these suggested remedial approaches are contradictory in themselves, further confusion is added by the assertion that autistic children are neither underaroused nor overaroused, but vascillate between the two conditions (i.e., exhibit perceptual inconstancy) (Ornitz & Ritvo, 1968). It is no doubt difficult for educators to implement effective remedial strategies based on the inconclusiveness of this evidence.

One of the most profound methodological difficulties faced by those looking at physiological characteristics of

autistic children (i.e., Graveling & Brooke, 1978; Hermelin & O'Connor, 1968; Lelord, Laffont, Jusseaume, & Stephant, 1973; Small, 1971) has been the development of reliable methods of measuring responses of subjects who are generally uncooperative. The studies described by these authors typically use a variety of measures (i.e., evoked responses, EEG, mucoprotein secretions) and are therefore often difficult to compare. Tentative data show that autistic children are more variable and irregular in response to stimulation (Lelord et al., 1973; Small, 1971), have a significantly longer brainstem transmission rate than normals in response to auditory stimuli (Student & Sohmer, 1978), and adapt more quickly to light stimulation than normal children (Hermelin & O'Connor, 1968). While a detailed analysis of these studies is beyond the scope of this paper, we can assume that much more research is necessary in this area before the relevant information may be used in practical teaching situations.

Perceptual-Cognitive Deficits in Autism: Remedial Strategies

Before concluding this section, I will briefly describe some efforts made by educators to remediate reported perceptual-cognitive deficits in autistic children. One of the primary areas of concern has been language acquisition. Research reviewed previously suggests that autistic children do not respond to sound or verbal stimulation in a manner typical of normal children. It is not surprising to discover that one of the classic symptoms

of autism is failure to develop language. Most autistic children are typically mute or evidence what is known as echolalia (Rutter, 1978). This language deficit understandably impedes learning by conventional teaching methods.

To overcome this problem educators have recently begun to implement what is known as the simultaneous communication method of language instruction (see Carr, 1979). This involves pairing verbal instruction with manual sign language to facilitate the acquisition of language skills. Casey (1978) found that this technique, when implemented by parents and teachers, helped to increase communicative behavior and decrease inappropriate behaviors in a group of four autistic children with some limited speech. In his review of the literature, Carr (1979) reported that while echolalic autistic children seemed to benefit from this method, the lower-function mute autistic children seemed to attend primarily to the manual signs and not to the verbal instruction. As a result, the latter group made only minimal gains in verbal communication, but they did learn some expressive sign language. In general, this method of communication training has proved very valuable to educators working with autistic children.

The success of the simultaneous communication method of language training has led to speculation regarding the use of modality strengths in teaching autistic children. Educators have asserted that because the children evidence differential

rates of learning to visual and auditory stimulation, efforts should be made to provide instruction in the sensory modality which is most utilized by each child (see Poulton & Algozzine, 1980; Servetter & McComiskey, 1979). However, at present, no systematic attempt has been made to provide support for these assertions.

In the final portion of this paper I will present the results of three systematic experiments, conducted in our laboratory, which were designed to examine the relationship between modality "preference" and rate of acquisition of a discrimination task. First, autistic children's preference for colored lights and/or simple tones was assessed in a sensory conflict paradigm (i.e., opportunity to respond to light or tone, but to only one of the pair at any given time). Next, these stimuli were incorporated into a simple serial discrimination task to determine whether stimulus preference was related to the speed at which children learn a discrimination. Finally, attempts were made to determine whether learning would transfer to school-related material (e.g., pictures and/or words). The implications of this type of research are of great importance to educators. If a child attends to a task more readily when it is presented in his/her preferred modality, it would be suggested that more use be made of that modality in the child's classroom setting. Conversely, if the preferred stimuli have sufficient reinforcing value in themselves to

interfere with learning when incorporated into a simple task, we might consider the development of teaching strategies centered primarily around the nonpreferred modality. It is hoped that the information derived from these experiments will be of practical use to educators of autistic children.

CHAPTER III

EXPERIMENT 1

INTRODUCTION

As discussed earlier (see review), little conclusive evidence has been provided regarding sensory modality preferences in autistic children. While these children were observed to respond differentially to certain types of sensory input, the concept of a hierarchy of receptor preferences (or sensory dominance) was abandoned in favor of theories of faulty information processing and/or overselective attention. However, recent work in the area of hemispheric dominance (i.e., Blackstock, 1978) has rekindled some interest in the area of sensory preferences. Blackstock (1978) reported finding that autistic children preferred stimulation which would be processed by the right hemisphere of the brain (music) over stimulation which would be processed by the left hemisphere (verbalizations), while normal children showed no specific preference for either type of stimulation. Blackstock suggested that the right hemisphere is more active than the left in autistic children, and that these children may be best able to process information associated with right-side processes.

While these findings are tenuous and in need of further replication, they have provided researchers with the impetus

to discover exactly what type of stimuli have the most significant impact on autistic children. Rincover, Newsom, Lovaas, and Koegel (1977) utilized a bar-press task to assess the preferences (i.e., reinforcing value) of both visual (light and movement) and auditory (music) input in four autistic children. They found different preferences across children, with one responding at a higher rate for auditory input, and the other three responding more frequently for visual input (two preferred light and one movement). These preferences were found to be stable over time and to be related to each child's self-stimulatory behavior.

In a more recent study, Stover-Turchin (Note 1) attempted to assess the preferences of eight autistic children for the auditory or visual modality. Each child was given the opportunity to press a button in order to receive either a flickering light or a modulated tone. By examining the number and duration of button presses for each stimulus, he found that two of the eight children preferred light, while one preferred tone.

Certain methodological problems in both the Rincover et al. (1977) and the Stover-Turchin (Note 1) studies make their conclusions about stimulus preferences in autistic children somewhat questionable. Each of these experiments consisted of a situation in which a child was required to press one bar (or button) to receive one type of stimulus presentation. The available stimuli were presented successively, and the number of presses

for each stimulus determined the stimulus preference of a child. In no instance were the children permitted to choose between two different types of stimulus input available at the same time. Therefore, we are unable to determine the relative reinforcing value of stimuli from different modalities.

Another possible confounding variable concerns the presence of an experimenter in the room while the children were performing the task. It is difficult to determine to what extent the experimenter's presence acted as a controlling factor in affecting the responses of the children. For many autistic children (and particularly those who have been exposed to a fairly stringent schedule of reinforcement in educational settings) the presence of an adult has become a cue to perform in a manner which is less than spontaneous (Gersten, 1980). When these children are observed alone (i.e., in a play situation), it is not unusual to observe prolonged periods of self-stimulatory and other "inappropriate" behavior (Lovaas, Litrownik, & Mann, 1971). There is some doubt then whether similar results would have been obtained in the above-mentioned studies had the children been alone in the experimental room.

In Experiment 1, preference for specific auditory or visual stimuli were assessed in a sensory conflict paradigm. Two buttons were used in this study. Stimuli from the two different modalities were always available to choose from at any given time (each one being associated with a different

response manipulanda). While an experimenter was present in the training phase of the experiment, her interactions with the children were minimized, and the children were left alone during the actual assessment period. Thus, the children were given an opportunity to respond, or not respond, as they chose. As a result, a more accurate assessment of stimulus preferences was obtained.

Because the ultimate goal was one of examining the relationship between stimulus preference and rate of learning, only simple stimuli (i.e., colored lights and pure tones) within the visual and auditory modalities were included. It was hoped that when these stimuli were incorporated into a subsequent discrimination task, learning would be facilitated in the absence of complex stimulus components.

METHOD

Subjects

A total of 11 autistic children were administered the Cattell-Binet Short Form Intelligence Test (Alpern & Kimberlin, 1970). This general test, developed specifically to assess "untestable" children, has a correlation of .97 (see Alpern & Kimberlin, 1970) with the Cattell Infant Intelligence Scale and the Stanford Binet Intelligence Scale. Testing took place approximately 5 months prior to each child's exposure to the

initial experimental condition. Two additional subjects were recruited after the assessment procedure had been completed. Information regarding the testing history of one of the children was derived from his case file, and no information was available for the other child. MAs, CAs, and IQs for each child are presented in Table 1.

The subjects included 10 boys and 3 girls attending Los Ninos Center (San Diego), a nonprofit treatment facility for children with central communication disorders. They ranged in age from 5 to 12 years. All had been diagnosed autistic by agencies not affiliated with the study. Each child demonstrated the essential characteristics of autism described by Rutter (1978), i.e., evidence of onset before 30 months of age, impaired social development, delayed and deviant language development, and "insistence on sameness" as shown by stereotyped play behavior, abnormal preoccupations, or resistance to change. Subjects had been attending Los Ninos Center for between 5 months and 4 years, and participation in education and treatment programs had reduced some of the childrens' classically autistic behavior. Limited receptive language was exhibited by all of the children; nine were functionally mute (i.e., lack of verbal communicative skills), three had some speech which was mainly echolalic, and one demonstrated spontaneous speech. All of the children had some limited expressive skills (e.g., simple sign language, communication

TABLE 1

CAs, MAs, and IQs of Subjects

Subject	CA	MA	IQ	Test
Erin	5-1	3-0	55	Cattell-Binet
Tony	5-7	2-11	51	Stanford-Binet
Eric	9-11	4-0	41	Cattell-Binet
Jason	11-1	3-9	38	Cattell-Binet
Jimmy	12-3	3-3	34	Cattell-Binet
Dude	6-1	2-0	33	Cattell-Binet
LaMar	5-7	1-9	31	Cattell-Binet
Tiffany	6-1	1-9	29	Cattell-Binet
Billy	6-11	1-9	25	Cattell-Binet
Johannes	8-6	1-9	20	Cattell-Binet
Tammy	5-9	12.5 Mo.	18	Cattell-Binet
Gary	8-2	1-4	16	Cattell-Binet
David		Information unavailable		

board, limited verbal ability) largely as a result of their participation in the program at Los Ninos Center.

Setting

The experiment was conducted in a 2.43m x 1.79m windowless room. A table (2.43m long, 70cm wide, and 60cm high) was abbutted to the rear wall of the room, and a bench (2.43m long, 27cm wide, and 28.5cm high) was fastened to the floor, 31cm from the table. A skylight, located in the ceiling, was partially opened to allow circulation of air and provide some illumination of the room. Observation of the children's behavior was made through a two-way mirror located in the wall separating the experimental and control rooms.

Apparatus

The stimulus box (18cm square and 23½cm high) was located in the center of the table, 1.13m from each side wall, and affixed to the rear wall. In this way, only three of its sides could be viewed by the children. The top of the box was at eye level for the smallest child when seated at the bench. The stimulus box consisted of two parts. The wooden base (18cm square and 12½cm high) was perforated on all sides to facilitate the emission of tones from a 9½cm speaker housed within. Recorded material was fed to the speaker through a connection from a tape recorder (Sankyo, Model ST-40) in the control room. The upper portion of the stimulus box (18cm square and 11cm high) was constructed of clear, corrugated plastic, and concealed two light bulbs protruding from sockets located side by side on the inside of

the rear wall of the box. When a light bulb was illuminated, the ridges in the plastic reflected the color of the light in such a way that the entire upper half of the stimulus box took on the color of that particular light bulb.

Two white plastic buttons (2cm square and ½cm high) were mounted into two blocks of wood (8½cm square and 5cm high) located at opposite ends of the table. Each block of wood was glued to the table surface, 4cm from the edge and 26cm from each of the side walls. A distance of 1.71m separated the buttons to insure that while each one was equally accessible, the children could not press both simultaneously. Pressing a button resulted in one of two possible outcomes: (1) a 3-sec presentation of a tone; or (2) a 3-sec presentation of light. The type of stimulus available at a particular button at any given time could be manipulated by flipping a switch located on a BSR input/output relay system in the control room.

In addition to determining which stimulus would be available at each button, the relay system allowed the experimenter to alter the number of presses required to produce a stimulus presentation. This was necessary during the training procedure (described below). Recordings of the number of presses of each button, and the number of presentations of each stimulus were tallied automatically by counters on the control panel.

Procedure

Training. The two stimuli utilized during training were a blue, 40-watt light, and a 1000Hz, 74dB tone. All tones used in this study were generated by a Tektronics TM-FG504 Functions Generator and recorded onto a cassette tape. Decibel levels were measured by a G-R 1551-C Sound Level Meter. The children were brought individually to the experimental room, seated on the bench in front of the stimulus box, and then immediately moved to a position directly facing one of the two buttons. The side on which training began, as well as the type of stimulus (i.e., light or tone) first presented, was determined randomly for each child. The initial placement of the child in front of the apparatus had a dual purpose: (1) to insure that the child did not develop a position habit, i.e., go to one side of the room first as opposed to the other, and (2) to prepare him/her for the testing sessions in which all subjects would be left alone in front of the stimulus box.

Each child was taught to press the button in the following manner: A female experimenter stood behind the child, pointed to the button, and said, "Press." Once the child achieved a fairly consistent level of responding without the verbal prompt, the experimenter moved as far as possible away from the child and out of his/her line of vision. Throughout training, the experimenter initiated only as many prompts as were necessary for the child to reach the criterion level of responding.

The ultimate goal for training was to achieve an FR-5 level of responding (i.e., 5-button presses producing a 3-sec stimulus presentation). If the child achieved one stimulus presentation within 10 sec of the initial verbal ptompt, he/she was permitted to continue to press the button. Criterion for training was considered met if the child obtained three additional stimulus presentations (requiring 15 presses) within the 1-minute period following the initial presentation. Immediately after training on the first button, the child was moved to the other button, and this procedure was repeated. If the child succeeded at the second button, obtaining one stimulus presentation within the first 10 sec after the verbal prompt and three presentations in the following minute, he/she was considered trained on an FR-5 schedule of pressing, and the session was discontinued.

If the child did not fulfill the criterion described above, the following steps were taken.

Step 1. If after the verbal prompt, "Press," the child did not receive one stimulus presentation within 10 sec, the prompt was repeated and another 10 sec allowed for responding. If criterion was not then met, the child was moved immediately to Step 2 of the training schedule. If the child received one stimulus presentation in the initial 10 sec and failed to obtain three more presentations in the following minute, the verbal prompt was repeated and a second chance was given. If criterion

was not met, the child was moved to Step 2. If the criterion was met, the child was moved to the alternate button.

Step 2. The schedule of reinforcement in this step was changed from FR-5 to CRF, that is, for each button press, the child received one stimulus presentation. After the verbal prompt, "Press," was given, the child was required to obtain one stimulus presentation within 5 sec. If this was achieved, four more presentations were required within the following 25 sec to meet criterion on Step 2. If the child succeeded, he/she was moved to Step 3. If the child did not achieve one presentation in 5 sec, or four additional presentations in the following 25 sec, a second verbal prompt was given. If criterion was then met, the individual was advanced to Step 3. However, if the child failed to reach criterion after two verbal prompts, a physical prompt was introduced. The experimenter placed the child's hand on the button, and while saying, "Press," pushed down on the button to obtain a stimulus presentation. The child was then permitted to continue to press the button to achieve four presentations in the following 25 sec. If this criterion was met, the child was advanced to Step 3. If he/she did not continue to press, additional physical prompts were initiated. If, after a maximum of 10 physical prompts or 5 minutes had elapsed and the child did not reach criterion, the training session was discontinued for that day.

Step 3. The procedure in Step 3 was similar to that of Step 2, with the following exceptions: (1) the reinforcement schedule was changed to FR-2, requiring two button presses for one stimulus presentation; (2) the child was required to obtain the first presentation within 10 sec of the verbal prompt; and (3) the child was required to obtain four additional presentations within 50 sec of the first presentation. Verbal and physical prompts and criterion for discontinuance remained the same as those employed in Step 2. Advancement to Step 4 was contingent on success at Step 3.

Step 4. The schedule of reinforcement in Step 4 was FR-3, or three presses required for one stimulus presentation. The child was required to obtain one presentation within 10 sec of the verbal prompt, and four additional presentations within the following 70 sec. Training procedures were identical to those described in Step 2. Advancement to Step 5 was contingent on success at Step 4.

Step 5. Step 5 of the training procedure was identical to Step 1. Five presses were required to obtain one stimulus presentation. If criterion was met at this level, the child was moved to the alternate button. If the child did not achieve an FR-5 level of responding, he/she was returned to Step 2 and the entire procedure was repeated. Training was discontinued

after the child learned the task (on both buttons), or after a maximum of 20 minutes. Children who failed to learn were brought back for additional training the following day. Regardless of where each child's session had been terminated in the training schedule, all children who participated in the second day of training were begun at Step 1. A maximum of 2 days of training was given each child.

If a child was required to go through the five training steps on the first button, he was automatically required to go through the same steps on the second button, regardless of whether or not he/she met the criterion for FR-5 responding in Step 1 on the second button. This was to insure that each child had approximately equivalent exposure to both buttons and both types of stimuli. The schedules of reinforcement were manipulated manually by a second experimenter in the control room, and he was given cues by an observer who watched the entire procedure through the two-way mirror. Both the observer and the first experimenter kept a record of the number of trials needed for each child at each step.

Testing

Each child received 12 8-minute sessions during the testing period, with no more than one session per day, and not less than one session every three school days. The stimuli used in this phase were as follows: (1) a red, 40-watt light; (2) a yellow,

40-watt light; (3) a 700Hz, 71dB pure tone; and (4) a 1300Hz, 81dB pure tone. The tones will hereafter be referred to as Tone A and Tone B, respectively. These stimuli were chosen mainly for their simplistic composition. Because they were to be used in a discrimination learning paradigm in Experiment 2, we felt that we would maximize the chances of the children's learning if we kept the stimuli as simple as possible. Although it has been shown that autistic children respond differentially to various intensities of visual and auditory stimulation, we made no effort to equalize the intensity levels of the lights and tones in our experiment. This was largely because our main interest was not in whether the children would prefer one stimulus modality over the other. We were more interested in determining whether a child who chose to respond to a particular stimulus or stimulus modality would learn a simple discrimination task in that modality with greater ease (or more difficulty) than a similar task in the nonpreferred modality.

During each 8-minute session, only two stimuli were available (i.e., one type of light and one tone). All of the children received equal exposure to the four stimuli over sessions, however, the order of presentation of each combination of stimuli (i.e., Yellow/Tone A; Yellow/Tone B; Red/Tone A; Red/Tone B) was randomized for each child. Each combination was available during three of the 12 sessions.

The children were led into the experimental room individually, and seated in the middle of the bench. The experimenter then walked over to one of the buttons (determined randomly), established eye contact with the child, and said, "Watch me." When the child made eye contact, the experimenter pressed the button five times and obtained a stimulus presentation. This procedure was then repeated at the second button. After the demonstration was completed, the experimenter again established eye contact, gave the prompt, "Press the one you want; press the button!" and left the room. The session was then started.

Each 8-minute session was divided into four blocks of 2 minutes, and the number of presses for and presentations of each stimulus was recorded at the end of each 2-minute block. This procedure permitted the examination of the quality of a child's response (e.g., pattern of responding, satiation, etc.). In addition, a second experimenter recorded the child's behavior as observed through the one-way mirror. For at least one-half of each subject's sessions, the second experimenter also recorded data in order to establish the reliability of the obtained scores.

RESULTS

Of the 13 children who served as subjects for the experiment, two failed to meet the training criterion, and four were excluded due to behavior problems incurred during the testing

period. One of the two children who did not meet training criterion appeared to be under rigid experimenter control, refusing to initiate a button-pressing response without a verbal prompt. The other child showed no interest in the stimuli, and had to be held in place by the experimenter while learning the task. After two unsuccessful training days, these children were eliminated from the study.

The remaining four children met the training criterion but their button-pressing behavior could not be maintained when left alone in the experimental room (i.e., during the testing phase). Without the experimenter present, self-stimulatory and other task-irrelevant behaviors (i.e., crying, breaking the stimulus box) precluded responding to the available stimuli. Two of the children typically took off their shoes and socks and rubbed their feet on the carpet. While it was hoped that given enough sessions in the room these children would eventually begin to press the buttons, three out of four of the children obtained two or less presentations of any stimulus on any day. Additional training sessions failed to facilitate responding. Although the fourth subject pressed the button more frequently, he usually did so while attempting to dismantle the stimulus box. Data for these subjects are not included in the descriptive analysis.

Of the seven children who did complete the experiment, five met the training criterion immediately (i.e., achieved FR-5 responding with one verbal prompt). The remaining two

children required training on steps 1 through 5 (once through on each button). Patterns and rates of responding during the test phase were extremely variable, and are discussed in detail for each child. Interscorer reliability was as follows: (1) number of presses for light in each 2-minute block (.99); (2) number of presses for tone in each 2-minute block (.97); (3) total number of presses for light within a session (1.0); (4) total number of presses for tone within a session (.99).

Each child's data were initially examined to determine position habits and rates of responding over time. This information helped to determine the reinforcing value of the stimuli presented in the experiment. Due to the variability of response rates between children, stimulus preferences were calculated in terms of percentages and ratios. A strong preference was defined as twice as many responses to one type of stimulus than another (i.e., ratio of two or more to one), a moderate preference as .51-1.99:1, a weak preference as 1.31-1.5:1, and no preference as 1.3 or less to 1). Three measures were used to determine stimulus preference: (1) ratio of total presses for visual to total presses for auditory stimuli; (2) ratio of total sessions where a light preference was evidenced to total sessions where a tone preference was evidenced; (3) ratio of 2-minute blocks where a light preference was exhibited to 2-minute blocks where a tone preference was exhibited. Data for each child will now be presented.

Jimmy

Pattern of responding

a. Position habit. Jimmy exhibited a weak (1.32:1) overall preference for the button on the right side. Inspection of Figure 1a reveals that this preference was initially very strong (4:1) through the first four sessions, but was greatly reduced by sessions 5 through 8 (1.4:1), and finally, eliminated by sessions 9 through 12 (1.1:1).

b. Response rates over time. Figures 1b and 1c show Jimmy's response rates over and within sessions. An increase in his button-pressing behavior was evidenced over sessions, with 9% of his responses occurring in sessions 1 through 4, 39% in sessions 5 through 8, and 59% in sessions 9 through 12. A consistent level of responding was maintained within sessions, though, with 25% of his presses occurring within the first 2-minute block, 26% in the second, 24% in the third, and 25% in the fourth.

Comment. The strong position preference and relatively low rate of responding exhibited by Jimmy in the first four sessions suggests that the available stimuli did not initially have a potent reinforcing value. As the sessions progressed, the position habit became less obvious and a dramatic increase in the level of responding occurred. This implies that one or more stimulus had acquired salience for Jimmy.

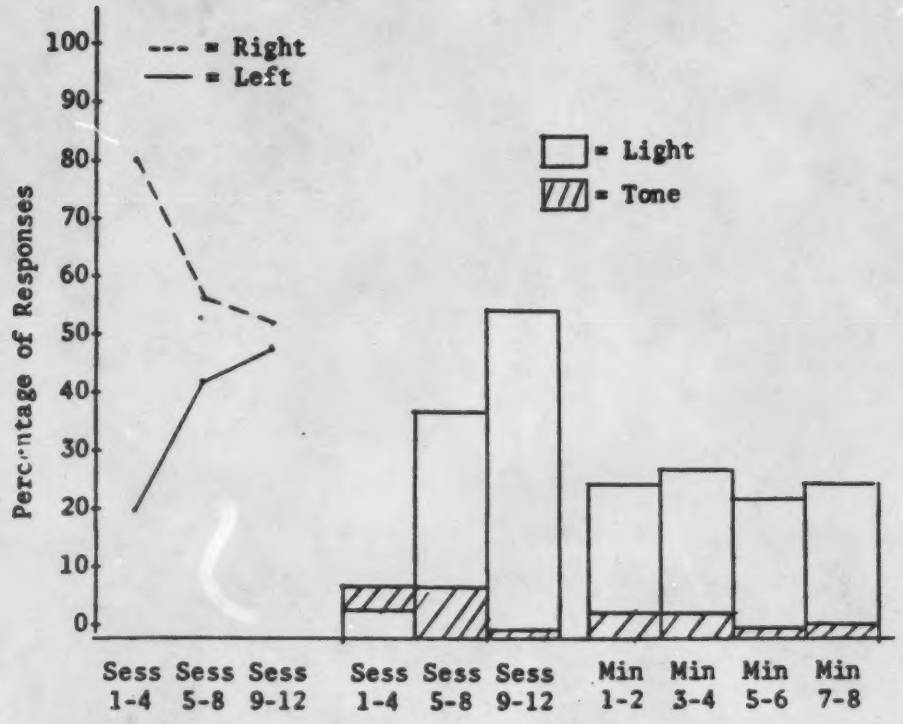


Figure 1. Jimmy: Pattern of responding.

Stimulus preferences

a. Visual versus auditory. A summary of Jimmy's stimulus preferences is presented in Table 2 and Figure 2. Jimmy exhibited a strong (5.76:1) preference for visual stimuli, with 85% of the total number of his presses occurring for light, and 15% for tone. Similarly, he showed a visual preference in 75% of his sessions (3:1), and 83% of his 2-minute segments (5:1). On all three measures, then, Jimmy demonstrated a strong preference for light. This preference was maintained within and over sessions (see Figures 1b and 1c).

b. Red versus yellow; Tone A versus Tone B. Figure 2 and Table 3 show Jimmy's data for preferences within modalities. He exhibited a weak (1.3:1) preference for the red light as compared to the yellow light, and a strong (13:1) preference for Tone A over Tone B.

Behavior. Jimmy maintained a high level of self-stimulation throughout the 12 sessions. He typically initiated the onset of the light by rapidly pressing the appropriate button, and then proceeded to wave his hand or flap his ear while gazing at the stimulus. Immediately after the light turned off, the self-stimulatory behavior ceased, and he proceeded to press the button again. As the light came on, the cycle was repeated. It seemed that the light was in some way acting to trigger Jimmy's own repertoire of self-stimulatory behaviors.

TABLE 2

Stimulus Preferences: Light Versus Tone

Subject	Total No. Presses	Total Light	Total Tone	Ratio	Preference	Strength	No. of Sessions: Light Preference	No. of Sessions: Tone Preference	Ratio	Preference	Strength	No. 2-Minute Segments: Light Preference	No. 2-Minute Segments: Tone Preference	Ratio	Preference	Strength
Jimmy	2565	2192	373	5.88:1	Light	Strong	9	3	3:1	Light	Strong	40	8	5:1	Light	Strong
Eric	5897	4382	1525	2.87:1	Light	Strong	10	2	5:1	Light	Strong	33	12	2.75:1	Light	Strong
Erin	1558	1061	497	2.1:1	Light	Strong	11	1	11:1	Light	Strong	33	11	3:1	Light	Strong
Dude	1986	1150	846	1.37:1	Light	Weak	6	2	3:1	Light	Strong	15	9	1.67:1	Light	Moderate
Tony	2569	1142	1127	1.28:1	Light	None	9	3	3:1	Light	Strong	22	15	1.47:1	Light	Weak
Johannes	282	166	116	1.43:1	Light	Weak	3	5	1.67:1	Tone	Moderate	5	9	1.80	Tone	Moderate
Tiffany	1327	636	691	1.08:1	Tone	None	6	6	1:1	None	None	15	18	1.20	Tone	None

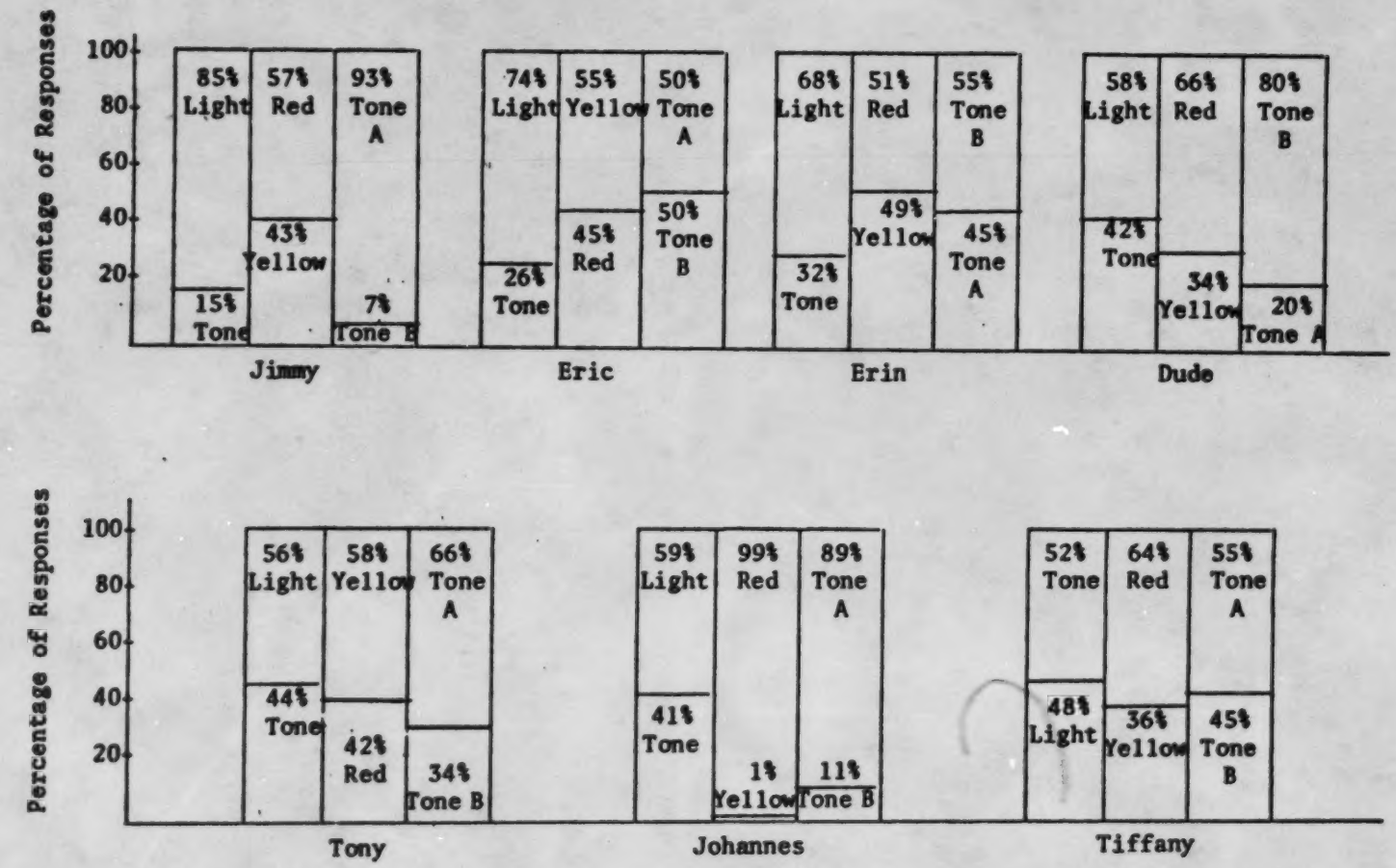


Figure 2. Stimulus preferences: Light versus tone; red versus yellow; Tone A versus Tone B.

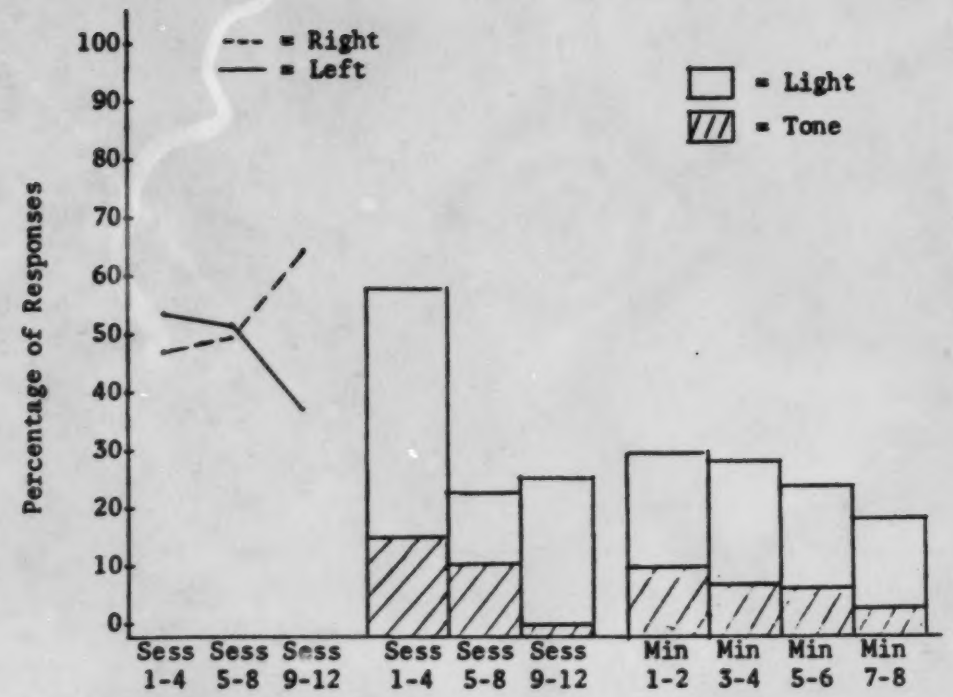
Eric

Pattern of responding

a. Position habit. Eric showed no evidence of an overall position preference. Figure 3a reveals that no position habit occurred in sessions 1 through 8, but a moderate preference was shown for the right side (1.6:1) in sessions 9 through 12. Examination of the data suggests that this preference was an artifact of the randomization procedure. Eric's preferred stimulus occurred on the right side in three out of four of these sessions.

b. Response rates over time. Figures 3b and 3c show Eric's response rates over and within sessions. The majority of his button-pressing responses occurred in the first four sessions (57%), with 22% in sessions 5 through 8, and 23% in sessions 9 through 12. Within sessions, 30% of Eric's presses occurred within the first 2-minute block, 29% in the second, 24% in the third, and 17% in the fourth.

Comment. Eric showed no evidence of a position habit, and immediately responded to the available stimuli. While his initial level of responding was high, the reinforcing value of the stimuli seemed to have decreased over time. Less than half (43%) of Eric's total presses occurred during his last eight sessions. This trend was also evident within sessions. Eric responded substantially more (59%) during the first half of the session than the last half (41%).



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 3. Eric: Pattern of responding.

Stimulus preferences

a. Visual versus auditory. A summary of Eric's stimulus preferences is presented in Table 2 and Figure 2. Eric exhibited a strong (2.87:1) preference for the visual stimuli, with 74% of the total number of his presses occurring for light, and 26% for tone. He showed a visual preference in 83% of his sessions (5:1), and in 69% of his 2-minute segments (2.75:1). On all measures, Eric showed a strong preference for light. This preference was maintained over and within sessions (see Figures 3b and 3c).

b. Red versus yellow; Tone A versus Tone B. Figure 2 and Table 3 show Eric's data for preferences within modalities. He evidenced no preference for either color of light, and no preference for either tone.

Behavior. Eric did not exhibit any unusual behaviors during the testing period. When prompted to "Press the one you want," he first pointed to the button which produced the light stimulus, and moved immediately to that button to begin pressing. He remained on task throughout the sessions.

Erin

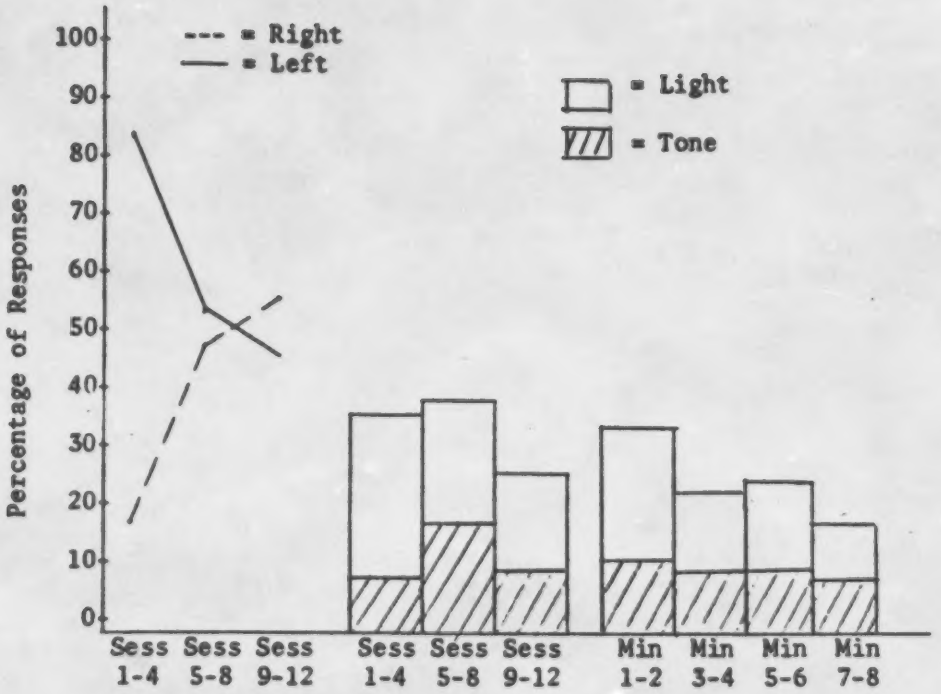
Pattern of responding

a. Position habit. Erin exhibited a moderate (1.55:1) overall preference for the button on the left side. Figure 4a reveals that while this preference was very strong (4.4:1)

TABLE 3

Within Modality Stimulus Preferences

Subject	Total Yellow	Total Red	Ratio	Preference	Strength	Total Tone A	Total Tone B	Ratio	Preference	Strength
Jimmy	927	1223	1.32:1	Red	Weak	353	27	13:1	T-A	Strong
Eric	2420	1962	1.23:1	Yellow	None	770	755	1.02:1	T-B	None
Erin	495	552	1.05:1	Red	None	225	272	1.2:1	T-B	None
Dude	391	768	1.96:1	Red	Moderate	169	677	4.0:1	T-B	Strong
Tony	834	608	1.37:1	Yellow	Weak	748	379	1.97:1	T-A	Moderate
Johannes	2	164	82:1	Red	Strong	107	13	8.2:1	T-A	Strong
Tiffany	229	407	1.8:1	Red	Moderate	381	310	1.2:1	T-A	None



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 4. Erin: Pattern of responding.

through the first four sessions, it had been eliminated by sessions 5 through 8 (1.1:1) and 9 through 12 (Right 1.26:1).

Response rates over time. Erin's response rates over and within sessions are displayed in Figures 4b and 4c. A fairly consistent rate of responding occurred in the first eight sessions, with 36% of her presses occurring in sessions 1 through 4, and 38% in sessions 5 through 8. A decrease in Erin's pressing behavior was observed in sessions 9 through 12 (to 26%). Within sessions, 35% of Erin's presses occurred in the first 2-minute block, 22% in the second, 24% in the third, and 19% in the fourth.

Comment. Erin exhibited both a position preference and a relatively high level of responding in the initial sessions. This suggests that while the available stimuli had some reinforcing value, they alone did not control Erin's button-pressing behavior. However, as the competing position habit diminished, Erin's response rate maintained its previous level. It was apparent that while the stimuli themselves retained their reinforcing value, the position habit did not. This continued to be true for the remainder of Erin's sessions, though her level of responding did decrease somewhat over time.

Stimulus preferences

a. Visual versus auditory. Erin's data for stimulus preferences are presented in Table 2 and Figure 2. Erin showed

a strong (2.1:1) preference for visual stimuli, with 68% of the total number of her presses occurring for light, and 32% for tone. She exhibited a visual preference in 92% of her sessions (11:1), and in 69% of her 2-minute segments (3:1). On all three measures, Erin demonstrated a strong preference for light. This preference was maintained over and within sessions (see Figures 4b and 4c).

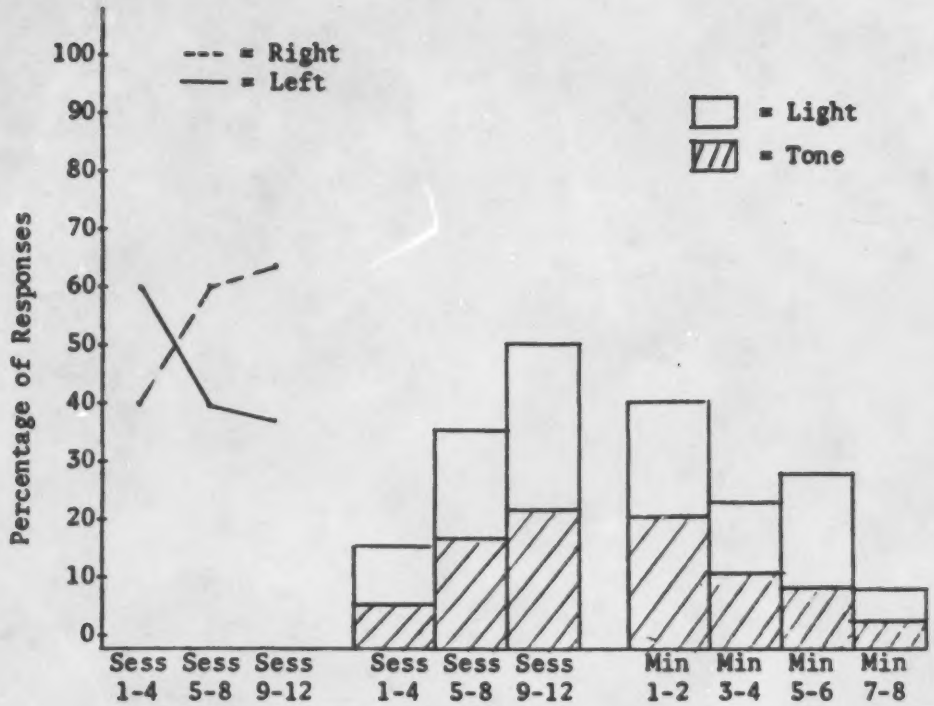
b. Red versus yellow; Tone A versus Tone B. Figure 2 and Table 3 show Erin's data for preferences within modalities. She evidenced no preference for either color of light, and no preference for either tone.

Behavior. Erin did not exhibit any unusual behavior during the testing sessions. She showed curiosity about the experimental room, and spent some time exploring, but always returned to the button.

Dude

Pattern of responding

a. Position habit. Dude demonstrated a weak (1.35:1) overall preference for the button on the right side. However, Figure 5a reveals that during sessions 1 through 4, Dude showed an initial moderate (1.5:1) preference for the left side. In sessions 5 through 8, the trend had reversed to a weak (1.4:1) preference for the right side, and continued to grow, in



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 5. Dude: Pattern of responding.

sessions 9 through 12, to a moderate (1.6:1) preference for the right button.

b. Response rates over time. Figures 5b and 5c show Dude's response rates over and within sessions. An increase in his button-pressing behavior was observed over sessions, with 15% of his total responses occurring in sessions 1 through 4, 35% in sessions 5 through 8, and 50% in sessions 9 through 12. Within sessions, the majority of Dude's presses occurred in the first 2-minute block (40%), with 23% occurring in the second, 27% in the third, and 10% in the fourth.

Comment. Due to the pervasiveness of position preferences throughout Dude's sessions, the reinforcing value of the available stimuli may be questioned. However, if we assume that the position of a particular stimulus was random on any given day, then a light and a tone should have been available at each button an equal number of times. If neither stimulus had any reinforcing value, the position habit (i.e., responding primarily to the button on the right) would have been dominant, and no preference for any particular stimulus would have been shown. I will now look at Dude's data for stimulus preferences.

Stimulus preferences

a. Visual versus auditory. A summary of Dude's stimulus preferences is presented in Table 2 and Figure 2. Dude showed

an overall weak (1.37:1) preference for visual stimuli, with 58% of the total number of his presses occurring for light, and 48% for tone. He showed a visual preference in 50%, and an auditory preference in 17% of his 12 sessions (3:1). Note that Dude did not respond during 4 of the 12 sessions (see below). Dude showed a moderate visual preference in 31% of his 2-minute blocks (1.67:1). Weak, strong, and moderate preferences for visual stimulation were exhibited by Dude on the three available measures. This indicates that while a position habit was indeed evident, it was not sufficiently strong to mask the reinforcing value of the visual stimuli.

b. Red versus yellow; Tone A versus Tone B. Table 3 and Figure 2 show Dude's preference within modalities. He exhibited a moderate (1.96:1) preference for the red light as compared to the yellow light, and a strong (4:1) preference for Tone B as compared to Tone A.

Behavior. Dude did not initiate any button-pressing responses during the first 3 days of the experiment. He typically sat on the bench and gazed into the mirror. On the fourth day of the study he began to press the buttons. However, the following day he did not respond. Beginning in Session 6, Dude began to press the buttons again and continued to respond throughout the remaining sessions. The only self-stimulatory behavior he exhibited was periodic toe-walking in front of the mirror.

Tony

Pattern of responding

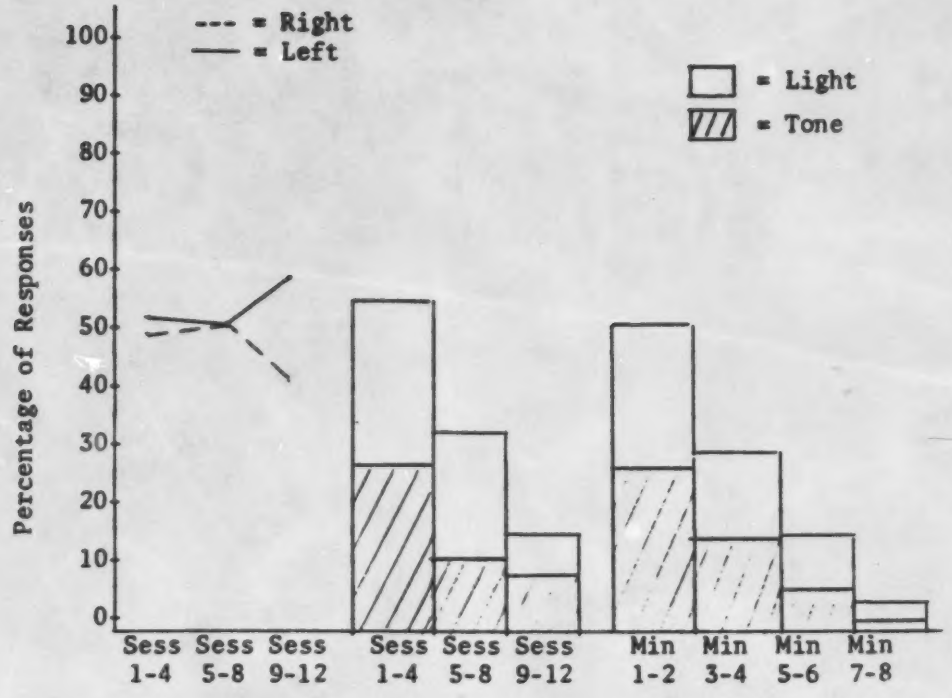
a. Position habit. Tony showed no evidence of an overall position habit. Figure 6a reveals that no position preference was observed in sessions 1 through 8, but a weak (1.4:1) preference for the left side was shown in sessions 9 through 12.

b. Response rates over time. Tony's response rates over and within sessions are shown in Figures 6b and 6c. The majority of his button-pressing responses occurred during sessions 1 through 4 (53%), with 32% in sessions 5 through 8, and 15% in sessions 9 through 12. A similar trend was observed within sessions, with 50% of Tony's presses occurring within the first 2-minute block, 29% in the second, 15% in the third, and 6% in the fourth.

Comment. Tony showed little evidence of a position habit and responded immediately to the available stimuli. While his initial rate of pressing was relatively high, the reinforcing value of the stimuli seemed to diminish over time. Tony did not maintain a consistent rate of responding over or within sessions.

Stimulus preferences

a. Light versus tone. Tony's data for stimulus preference are shown in Table 2 and Figure 2. Tony evidenced no



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 6. Tony: Pattern of responding.

overall preference for visual or auditory stimuli (light 1.28:1), with 56% of the total number of his presses occurring for light, and 44% for tone. However, he did show a preference for light in 75% of his sessions (3:1), and in 46% of his 2-minute segments (1.47:1). No preference, strong, and moderate preferences for visual stimuli were obtained on the three available measures.

A closer look at Figures 6b and 6c reveals that while the number of Tony's responses to light and tone were almost equal in sessions 1 through 4, his response rate for tone (19%) decreased far more rapidly than for light (29%) in sessions 5 through 12. The same trend was noted within sessions. Tony's responses for light (41%) and tone (38%) were obtained with a 3% difference in the first 4-minute block. In the final 4 minutes, that difference had increased to 9% (15% versus 6%). This suggests that though Tony did not exhibit a strong preference for the visual modality, the reinforcing value of the visual stimuli seemed to be greater than that of the auditory stimuli, over time.

b. Red versus yellow; Tone A versus Tone B. Table 3 and Figure 2 show Tony's data for within-modality preferences. He evidenced a weak (1.37:1) preference for the yellow light as compared to the red light, and a moderate (1.97:1) preference for Tone A over Tone B.

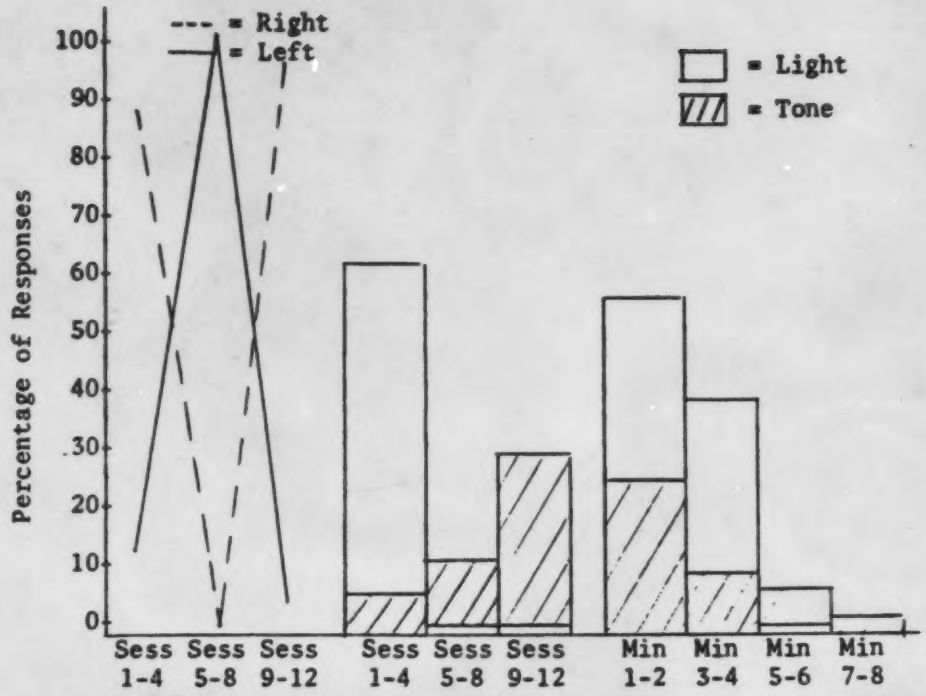
Behavior. Tony spoke constantly throughout the 12 sessions. Much of what he said was the result of his echolalia, and little of the content had any bearing on the experimental situation. In the last two sessions, though, he articulated his dislike for our laboratory, and in the final 2-minute block of his twelfth session, Tony stepped on the stimulus box and totally destroyed it.

Johannes

Pattern of responding

a. Position habit. Johannes exhibited a strong (4.53:1) overall preference for the button on the right side. However, examination of Figure 7a reveals that this preference was inconsistent over sessions. While a strong (7.2:1) preference for the right side was maintained in sessions 1 through 4, sessions 5 through 8 showed a reversal to a strong (27:1) preference for the left button. In sessions 9 through 12, Johannes reverted back to a strong (26.6:1) preference for the right button.

b. Rates of responding over time. Figures 7b and 7c show Johannes' response rates over and within sessions. The majority of his presses occurred in sessions 1 through 4 (61%), with 10% in sessions 5 through 8, and 29% in sessions 9 through 12. A similar trend was observed within sessions. Fifty-five percent of all presses occurred within the first 2-minute block, 37% in the second, 6% in the third, and 2% in the fourth.



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 7. Johannes: Pattern of responding.

Comment. The strong position preference exhibited by Johannes, combined with his substantially lower level of responding throughout the experiment (see Table 2), suggest that the available stimuli did not have significant reinforcing value for him. What value they did have seemed to diminish significantly over time. A closer look at Johannes' data shows that he refrained from responding in 4 out of 12 sessions, and pressed the button fewer than 10 times for any stimulus in an additional four sessions. Considering all of these factors, any interpretation of his stimulus preference is tenuous.

Stimulus preferences

a. Visual versus auditory. A summary of Johannes' stimulus preference is presented in Table 2 and Figure 2. He evidenced an overall weak (1.43:1) preference for visual stimuli, with 59% of his presses made for light, and 41% for tone. A moderate (1.67:1) auditory preference was exhibited both in 41% of his sessions, and in 19% of his 2-minute blocks (1.8:1). On the three available measures, then, Johannes showed a weak preference for light, and two moderate preferences for tone.

b. Red versus yellow; Tone A versus Tone B. Johannes' within-modality preferences are presented in Table 3 and Figure 2. He exhibited a strong (82:1) preference for the red light as compared to the yellow light, and a strong (8.2:1) preference for Tone A over Tone B.

Behavior. Johannes did not show interest in the available stimuli, and self-stimulated (twirled a string) throughout the majority of the sessions.

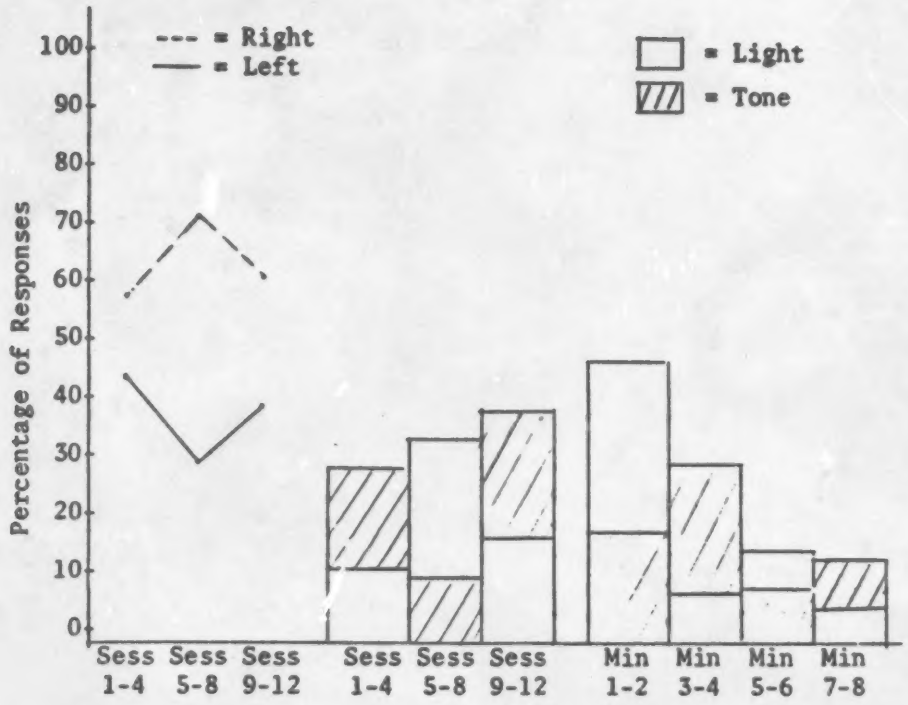
Tiffany

Pattern of responding

a. Position habit. Tiffany demonstrated a moderate (1.74:1) overall preference for the button on the right side. Inspection of Figure 8a reveals that while this preference was initially weak (1.35:1) in sessions 1 through 4, it became strong (2.4:1) in sessions 5 through 8, and moderate (1.6:1) in sessions 9 through 12.

b. Response rates over time. Figures 8b and 8c show Tiffany's response rates over and within sessions. A mild increase was shown in her button-pressing behavior over sessions, with 27% of her responses occurring in sessions 1 through 4, 33% in sessions 5 through 8, and 39% in sessions 9 through 12. Within sessions, an opposite trend was observed. The majority of Tiffany's presses occurred within the first 2-minute block, with 28% in the second, 14% in the third, and 13% in the fourth.

Comment. The pervasiveness of Tiffany's position habit suggests that while she did respond to the available stimuli, they may not have had a significant reinforcing value. Again we will assume that the position of any particular stimulus



a. Position preferences over sessions.

b. Response rate for light and tone over sessions.

c. Response rate for light and tone within sessions over 2-minute blocks.

Figure 8. Tiffany: Pattern of responding.

was random on any given day. In this situation, a preference for any particular stimulus would not have been shown if a competing position preference was sufficiently strong. We will now look at Tiffany's data for stimulus preferences.

Stimulus preferences

a. Visual versus auditory. Table 2 and Figure 2 show Tiffany's data for stimulus preferences. Tiffany evidenced no overall preference for either modality (tone 1.08:1). Fifty-two percent of her presses occurred for tone, and 48% for light. Similarly, no preference was shown either within her sessions (1:1), or within her 2-minute blocks (tone 1.2:1). Thus, Tiffany showed no preference for either modality or any of the available measures. It is apparent that in her case the reinforcing value of the available stimuli was less than that of the competing position habit.

b. Red versus yellow; Tone A versus Tone B. Tiffany's data for within-modality preferences are given in Table 3 and Figure 2. She exhibited a moderate (1.8:1) preference for the red light as compared to the yellow light, but no preference (Tone A, 1.23:1) for either of the tones.

Behavior. Tiffany maintained a relatively high level of self-stimulation throughout the 12 sessions. After initiating the onset of any particular stimulus, she would hum, grind her

teeth, and rub her face on the table. While she seemed to show interest in the available stimuli during the initial portion of each session, this interest waned quickly. Her remaining time was spent exploring the room, or lying quietly on the floor.

DISCUSSION

Of the seven children who successfully completed Experiment 1, six evidenced some preference for light (with three exhibiting a strong preference), and one evidenced no preference for either type of stimulus. These findings are consistent with those of Hermelin and O'Connor (1964). While no attempt was made to equate the relative intensity levels of the available stimuli in the present experiment, it was noted that only one of the subjects preferred the louder of the two tones. This is contrary to what would have been predicted by O'Connor and Hermelin (1965) and Metz (1967) and suggests that the evidence concerning stimulus intensity preferences in autistic children remains inconclusive and in need of further examination. The resolution of this issue seems particularly important when one considers that recommendations have been made to raise the overall level of sensory input for these children in classroom settings (see Metz, 1967).

Due to the limited number of subjects and the lack of a comparison group in the present study, it is difficult to

speculate as to the relationship between stimulus preference and level of intellectual functioning. However, a tentative comparison between Tables 1 and 2 suggests that with the exception of one child (Tony), those individuals with relatively higher IQ levels tended to show a stronger preference for light than those with lower IQs. That is, the light stimuli acquired relatively strong reinforcing value for these higher-functioning children.

The lower-functioning children (including those who did not complete the task) failed to exhibit a stimulus preference for one of two reasons: (1) an excessive preoccupation with self-stimulatory or other task-irrelevant behavior which precluded responding to the available stimuli, or (2) a pervasive position habit which dominated response patterns over sessions and thus made identification of a stimulus preference impossible. Reference to both of these phenomena has been made with regard to low functioning autistic children in previous literature. For example, Lovaas, Litrownik, and Mann (1971) found that mute autistic children learned a task less readily when engaging in competing self-stimulatory behavior. Similar results have been illustrated by Frankel, Freeman, Ritvo, and Pardo (1978). Lovaas, Litrownik, and Mann suggested that: (1) reinforcing stimuli generated by self-stimulatory behavior are exclusive and cannot be "enjoyed" during concurrent stimulation, and

(2) in autistic children, the reinforcing stimuli which maintain social and intellectual behaviors are so weak relative to self-stimulatory reinforcers as to leave a preponderance of self-stimulatory behaviors. The results of the present experiment are consistent with these assumptions in that the self-stimulatory behaviors exhibited by the children seemed to have far greater reinforcing value than the stimuli available through manipulation of the buttons. However, it is interesting to note that one of the subjects (Jimmy) utilized the light stimulus as a cue to initiate his typical self-stimulatory behavior. This suggests that there may be a stage in an autistic child's intellectual development (i.e., between total preoccupation with self-stimulation and responsiveness to environmental stimuli), and as he/she becomes more aware of the "outside world," in which the child attempts to incorporate external stimuli into his/her own frame of reference (i.e., self-stimulatory behavior). This is a highly speculative interpretation, though, and is in need of empirical support.

There is also evidence which indicates that lower-functioning autistic children will work harder for certain types of reinforcement. Researchers have shown that autistic children will perform at a higher level to produce stimuli most representative of their own self-stimulatory behaviors (see Frankel, Freeman, Ritvo, Chikami, & Carr, 1976; Rincover et al., 1977). Fineman (1968) found that while visual-color consequents were

somewhat effective in increasing verbalizations in a mute autistic child in a free operant situation, they were not as effective as food reinforcers in a prompt response situation. It is possible that the quality of stimuli in the present experiment was not of the type which would maximize the probability of eliciting responsiveness from these particular children.

The pervasiveness of position habits in response patterns of autistic children has been noted by O'Connor and Hermelin (1965) and Hermelin and O'Connor (1970). O'Connor and Hermelin (1965) found that unlike normal and retarded children, many of their autistic subjects evidenced a position preference rather than any particular stimulus preference. Further examination of the phenomenon revealed that discrimination tasks based on position were the ones most easily learned by autistic children (Hermelin & O'Connor, 1970). Hermelin and O'Connor speculated that this was largely because these position tasks rely on motor feedback and not on complex cognitive processes. While many of the subjects in the present experiment demonstrated an initial position habit, this habit was maintained over sessions only among the lower-functioning children. It may be suggested, then, that the lower-functioning children, due to their limited intellectual ability, could not move beyond a more "primitive" position preference to a more "advanced" level of responding (i.e., demonstration of responsiveness to lights or tones).

In summary, the majority of higher-functioning autistic children evidenced a preference for light in the present experiment. The lower-functioning children did not evidence any notable stimulus preference. There are a number of possible explanations for the latter finding, many of which implicate levels of intellectual functioning and their various relationships to self-stimulatory behavior. However, all of these interpretations are in need of further empirical support. What remains to be determined is whether stimuli which have (or have not) acquired reinforcing properties for these children will (or will not) acquire cueing properties for these children when incorporated into a discrimination learning paradigm. And more specifically, will those stimuli which proved to be the most reinforcing become more salient cues than those which were less reinforcing (i.e., predict the availability of food more readily). Experiment 2 attempted to address these issues.

CHAPTER IV

EXPERIMENT 2

INTRODUCTION

Experiment 2 was conducted to determine whether stimulus preference was related to rate of learning. The stimuli available in Experiment 1 were incorporated into two simple serial discrimination tasks (one visual, and one auditory) in Experiment 2. Children were required to press a bar in the presence of one specific light or one specific tone in order to receive a primary reinforcer. Pressing during the other light or tone had no consequence. The goal of this experiment was to determine (1) at what rate each discrimination was learned, (2) whether a child's particular stimulus preference was related to the speed at which he/she learned the discrimination in his/her preferred modality, and (3) whether the stimuli which acted as reinforcers in Experiment 1 would readily acquire a cueing value (i.e., signal the availability of food).

METHOD

Subjects

Six of the seven subjects who successfully completed Experiment 1 participated in Experiment 2. One of the subjects was unavailable for testing.

Setting

The same experimental room was used as that in Experiment 1. This time the table (1.79m long, 70cm wide, and 60cm high) was abutted to the side wall, and the bench (1.79m long, 27cm wide, and 28.5cm high) moved to within 23cm from the table. Access to the major portion of the table was cut off by a large wall (1.79m long and 1.36m high) which descended from the ceiling and was affixed to both side walls and the surface of the table. This immovable partition served to shield the apparatus from the sight of the children, but still allowed them a ledge (12cm wide) to work on.

Apparatus

A plexiglas panel (28cm long and 19.5cm wide) was mounted into the center of the front wall, 15.5cm from the surface of the table and at eye level for the smallest child. A rear-projection screen was glued to the plexiglas, on the other side of the wall, and visual stimuli were displayed on this screen by a Kodak Ectagraphic slide projector (model AF-3). Directly above the rear projection screen (and 16cm from the top of the screen) a speaker (9.5cm in diameter) was mounted onto the wall. Several holes were cut into the wall (18cm above the plexiglas panel) to allow sound to enter the experimental room. Auditory stimuli were fed into the speaker from two cassette tape recorders (Panasonic, model RQ-2309 and JC Penney, model 681-6567) located in the control room.

The barpress unit consisted of a plexiglas platform (7.5cm long and 5.5cm wide) fastened to a plexiglas lever (7cm long and .2cm wide). The lever protruded from the wall, 9cm below the center of the plexiglas panel and 4cm above the surface of the table. The bar was connected to an Apple II computer (located in the control room) which recorded the number of presses made by a given child, as well as the time at which each barpress occurred. In addition to recording barpress information, the computer was responsible for (1) determining the random sequence of the stimuli to be delivered, (2) initiating the onset of the appropriate stimuli, (3) signaling the experimenter if a particular bar press was correct (i.e., whether food should be delivered down the tube), and (4) calculating the percentage of correct versus incorrect responses in a given session.

The food delivery system consisted of an experimenter sitting behind the wall and dropping reinforcers down a plexiglas tube (4cm in diameter and 15cm long) into a plexiglas tray (13.5cm in diamater with a 5.5cm rim) which was glued to the surface of the table. The tray was located 21cm from the bar, and was easily within the visual range of the children.

Procedure

Training. Each child was brought individually into the control room and permitted to select the food reinforcer that he/she wished to work for (i.e., potato chips, M&Ms,

mints, crackers, etc.). A female experimenter then led the child into the experimental room and seated him/her on the bench directly in front of the bar. After establishing eye contact with the child, the experimenter (1) said "Watch me," (2) pressed the bar, (3) received a reinforcer, and (4) gave the reinforcer to the child. The experimenter then moved behind the child and out of his/her line of vision. A child was considered trained if he/she then pressed once within the first 15 sec, and nine more times within the following 105 sec (on a CRF schedule of reinforcement).

If the child did not press within the first 15 sec, the verbal prompt "Press" was given, and another 15 sec allowed for the first response. If this was achieved, the child was permitted to continue pressing to reach criterion. Training was discontinued immediately after criterion was met. If criterion was not met within the following 105 sec, the verbal prompt was reinitiated and the clock restarted. This procedure was repeated until the child learned the task.

If the child did not press once within 15 sec following the verbal prompt, a second verbal prompt was given, and the clock restarted. If one press was achieved within 15 sec, the child was permitted to reach criterion. If no response was made, a physical prompt was initiated (i.e., the experimenter placed the child's hand on the bar and, while pushing down on the bar, said "Press"). The child was then required to meet

the criterion for training (described above). If no spontaneous response was made during the first 15 sec, the physical prompt was reinstituted (up to a maximum of 10 physical prompts). If the child did respond in 15 sec, he/she was permitted to continue pressing until criterion was met.

Testing. The stimuli used in Experiment 2 were the same as those used in Experiment 1. The visual stimuli (i.e., red and yellow lights) were now in the form of slides presented on a projection screen. The practice of allowing each child a choice of reinforcers was continued throughout the experiment.

Two serial discrimination tasks (i.e., one visual and one auditory) were employed in Experiment 2. The discriminative stimuli (i.e., Sd) chosen for each child were the color of light and the frequency of tone identified as being least preferred in Experiment 1. However, due to mechanical failure on the first day of the experiment, two of the subjects received their preferred light stimulus as the Sd (Dude and Johannes) and one received his preferred tone as the Sd (Eric) throughout the course of the experiment.

Each testing session consisted of two 6-minute (approximate) segments, with either the visual or auditory discrimination occurring in each segment. The order of presentation of the two tasks was randomized over days. On the first day of testing, the children were required to reach a criterion of bar pressing

(i.e., five presses in 1 minute) before the first discrimination task was initiated. Any child who exhibited a low level of responding in subsequent testing sessions was required to reach this criterion before further testing took place. Alternatively, for children who exhibited an extremely high rate of responding (evidencing little or no selective responding to the stimuli after 12 sessions), the cue "No pressing" was given after the first press in every intertrial interval.

During each 6-minute segment, 11 5-sec presentations of Sd and 11 5-sec presentations of S^{Δ} occurred randomly, followed by intertrial intervals ranging from 5 to 15 sec, with a mean of 10 sec. Subjects were required to press the bar during the 5-sec presentation of the Sd in order to obtain the reinforcer. If a child successfully fulfilled this requirement, (1) the Sd was immediately turned off, (2) a reinforcer was delivered, and (3) the ITI began. Bar presses during the S^{Δ} or the ITI were not reinforced and were scored as incorrect responses. In addition, bar pressing during the S^{Δ} did not result in turning off that stimulus.

Testing sessions for each child continued until he/she responded correctly 90% of the time in a single segment on both discriminations (see below). That is, even if a child reached criterion on one task, testing on that task continued until the other task was learned. This procedure was employed to

insure that learning of the "nonacquired" discrimination would be subject to the same variables which influenced the learning of the "acquired" discrimination. No child received more than six sessions in 1 day, nor more than three consecutive sessions. Testing was spaced over a number of days with periodic breaks of up to 21 days due to mechanical failure of the mobile home in which the experiment was conducted.

To calculate the 90% criterion for successful acquisition of the task, events occurring within the discrimination were separated into units of one. That is, each Sd, S^{Δ}, and ITI constituted one unit for a total of 44 units within a segment (i.e., 22 stimulus presentations and 22 ITIs). Correct responding included barpressing during the Sd and not barpressing during the S^{Δ} or the ITI. In addition to recording the actual number of presses occurring within an event, each event was given a score of 0 or 1. The percentage of correct responding was then calculated on the basis of these scores.

RESULTS

Of the six children who participated in Experiment 2, five children met criterion for training immediately after demonstration by the experimenter, and one child (Dude) required two verbal prompts (i.e., "Press").

Due to computer failure during the initial days of testing, data for children who barpressed in excess of 130 times during

the course of a segment were unavailable for examination. Results were computed on available data and are presented below. In addition, mechanical failure of the mobile home in which the experiment was conducted resulted in large gaps between some sessions (of up to 23 days). These gaps are noted on the graphs of each child.

As was mentioned earlier, the children were required to meet a criterion of 90% correct responding on each discrimination before testing was discontinued. However, percentages calculated on the basis of this criterion failed to reveal certain anomalies in the quality of a child's response pattern. For example, if a child did not respond at all during a particular segment, he/she received a score of 75% correct. Recall that of 44 events within a segment, correct responding included pressing to 11 Sd's, and not pressing to 11 S^{Δ}'s, and 22 ITI's (or 75% of the total events). To avoid this problem, the following procedure was employed: The number of correct responses to the Sd was multiplied by 3, and the number of incorrect responses to the S^{Δ} and the ITI were subtracted from this number [3(number correct] - (number incorrect S^{Δ} + number incorrect ITI). The total possible number correct using this procedure is 33. Under normal circumstances, then, a score of 29/33 should yield the 90% criterion.

While this method allows for a more accurate description of a child's actual response pattern, there are notable problems

associated with it, mainly due to its post hoc construction. As was mentioned above, a score of 29/33, or a maximum of four errors, should yield the 90% criterion. However, if a child achieved seven correct responses to the Sd (i.e., four errors) and no incorrect responses (i.e., to the S^{Δ} or ITI), he/she would receive a corrected score of 21/33. This score fulfills the original 90% criterion but does not meet the corrected score criterion of 29/33. For this reason, an asterisk (*) is placed by the data point on each graph where the 90% criterion was met. With this caution in mind, the data and the statistical analysis performed, are presented on the basis of the corrected scores.

Table 4 reveals the number of segments each child required to meet criterion in the two discrimination tasks, as well as stimulus preferences derived in Experiment 1. For the purposes of statistical analysis, the children were divided into two groups: (1) those who evidenced a strong preference for light (Jimmy, Eric, Erin), and (2) those who evidenced a weak preference for light, or no preference (Tony, Dude, Tiffany). The number of segments for light were subtracted from the number of segments for tone, and a *t* test for the difference between two means for independent samples with unequal population variances was conducted on the data. While there appeared to be a trend toward superior performance on light trials by those who preferred light, this difference did not reach significance ($t(2) = 1.16$).

TABLE 4

Number of Segments to Criterion, Differences, and Stimulus Preferences

Subject	No. of Segments Light	No. of Segments Tone	Difference	Stimulus Preference	Strength	Group Assigned for Statistical Analysis
Jimmy	14	34	+20	Light	Strong	Preference
Eric	19	17	- 2	Light	Strong	Preference
Erin	14	18	+ 4	Light	Strong	Preference
Tony	15	14	- 1	--	--	No preference
Dude	--	--	--	Light	Weak	No preference
Tiffany	--	--	--	--	--	No preference

The mean number of correct responses for light and tone were calculated over sessions for each child, and are presented in Table 5. Again a difference score was obtained for each child, this time between the mean score for light and the mean score for tone. A t test between means for independent samples with homogeneous variance yielded a significant difference ($t(4) = 2.93$, $p < 0.05$) between the two groups of children. This indicates that those children who evidenced a strong preference for light performed significantly better on the light discrimination than on the tone discrimination than did the group which evidenced a weak preference for light, or no stimulus preference.

Figures 9 through 14 reveal each child's learning curves over the segments. Jimmy's data (see Figure 9) show a substantial difference between the number of segments he required to complete the light discrimination (14) and the number required to complete the tone discrimination (34). This result corresponds highly with his very strong light preference.

Eric (see Figure 10) exhibited a high rate of responding in the initial sessions, showing little or no evidence of acquisition of the discriminations. In his fifth session, a social reinforcer ("Good pressing, Eric") was paired with the food reinforcer in an attempt to help him discriminate between correct and incorrect responding. This additional reinforcer

TABLE 5

Mean Number Total Correct for Light and Tone Over Sessions and Differences Between Means (Mean Light - Mean Tone)

Subject	Mean Total Light	Mean Total Tone	Difference
Jimmy	20.5	7.13	13.34
Eric	11.3	9	2.3
Erin	20.16	15.41	4.75
Tony	21.2	21.9	- 0.7
Dude	0.52	3.19	- 2.67
Tiffany	- 3.58	- 1.41	- 2.17

proved ineffective in facilitating the discriminations, and on his fourteenth session, the prompt "No pressing, Eric" was added after his first press in each intertrial interval. This procedure drastically reduced the total amount of pressing, and within five subsequent sessions, both discriminations were learned.

Erin's learning curves are presented in Figure 11. Erin acquired the light discrimination in 14 segments and the tone discrimination in 18 segments. These results are consistent with her relatively strong light preference.

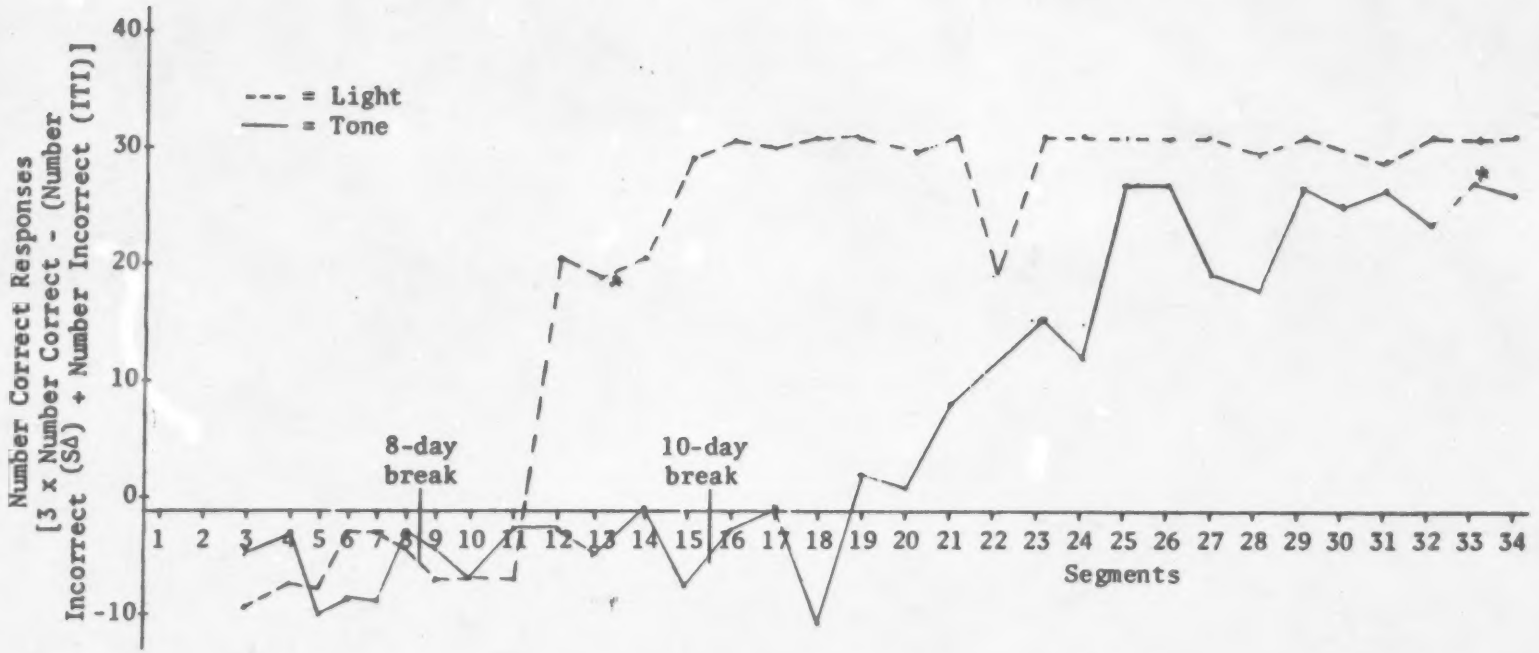

--- = Light
— = Tone
Number Correct Responses
[3 x Number Correct - (Number Incorrect (SΔ) + Number Incorrect (ITI))]
40
30
20
10
0
-10
8-day break
10-day break
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
Segments

Figure 9. Jimmy: Learning curves over segments.

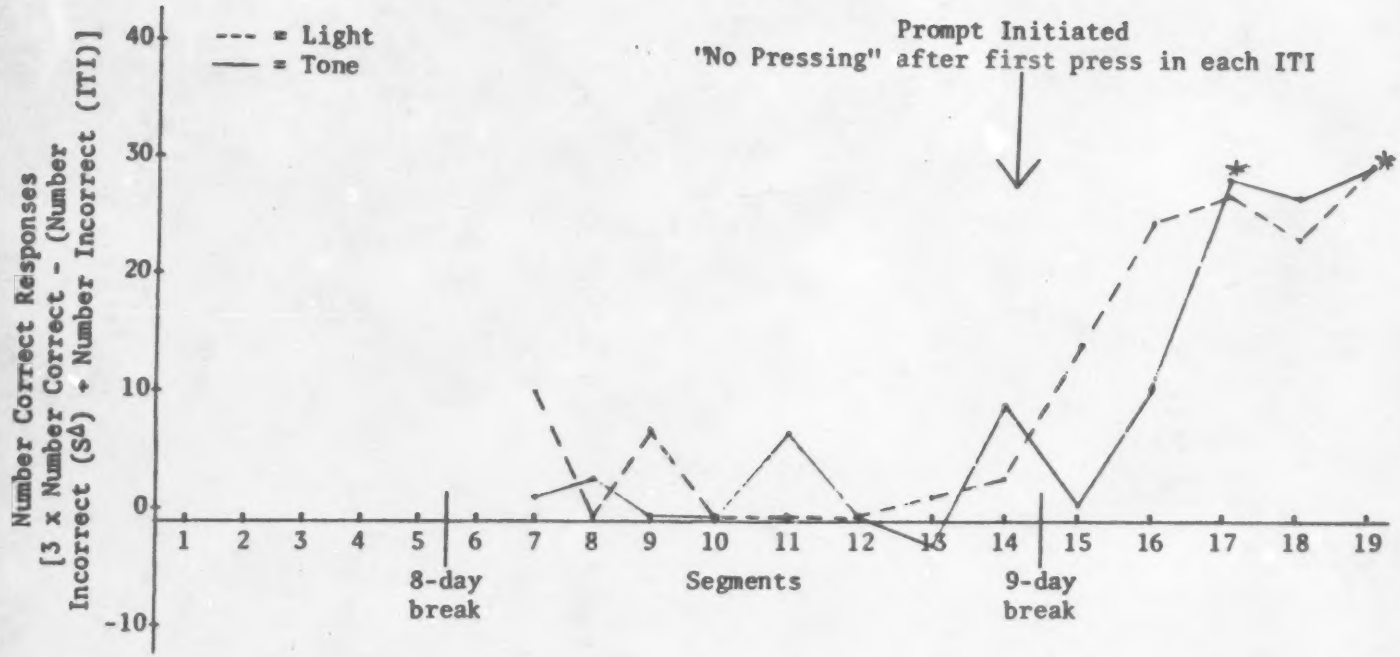


Figure 10. Eric: Learning curves over segments.

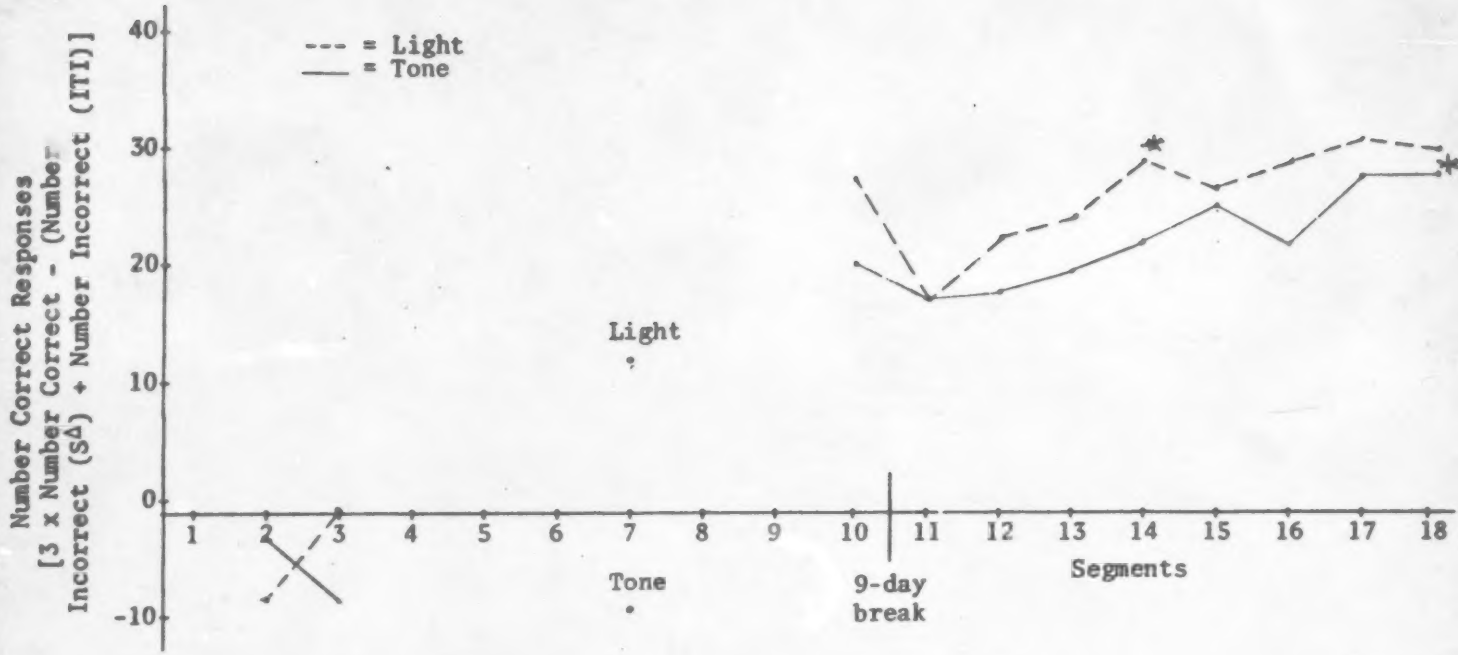


Figure 11. Erin: Learning curves over segments.

Tony's data (see Figure 12) indicate a difference of one segment (in favor of tone) in the acquisition of the discriminations. Observational data suggest that Tony may have acquired the light discrimination before the 90% criterion was met, as he often called for "Red" and pressed the bar, seemingly angrily, when the red light was not presented. His verbal behavior was much less pronounced during the tone segments, as he did not have a verbal label for his Sd tone. However, in the later segments he began to label his Sd tone "Red" and again began calling for the presentation of "Red," this time meaning the 1300Hz tone.

Neither Dude nor Tiffany was able to reach criterion on either discrimination (see Figures 13 and 14) after 49 and 32 sessions, respectively. Dude typically responded continuously throughout his sessions and Tiffany responded sporadically, but with no evidence of discrimination acquisition. The "No pressing" prompt was not initiated with Dude during his ITIs mainly because information derived from his teachers suggested that negative feedback would likely cause a total cessation in his responding. However, another prompting procedure was employed in Dude's 45th session and Tiffany's 32rd session in the hopes of improving their performance. An experimenter sat with each child during the session (on the bench at the child's left) and controlled barpress responding by taking the child's hand, and pressing down on the bar during the Sd, and prohibiting

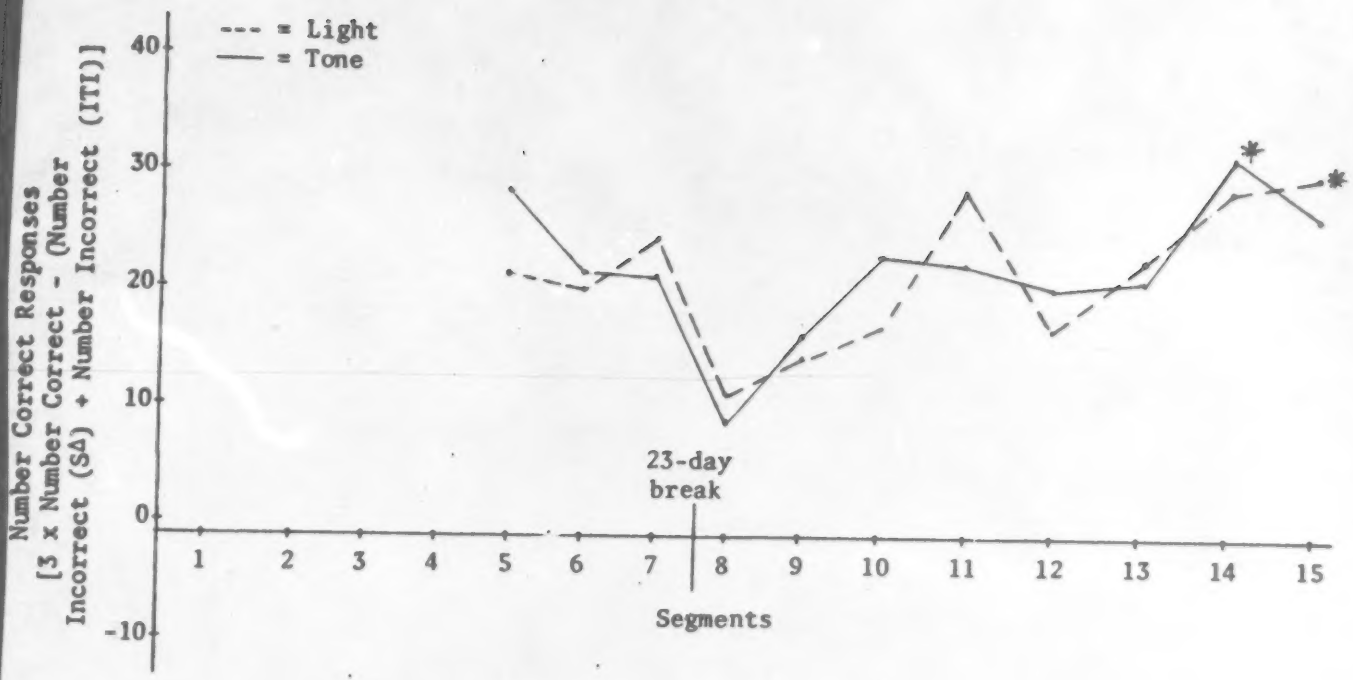


Figure 12. Tony: Learning curves over segments.

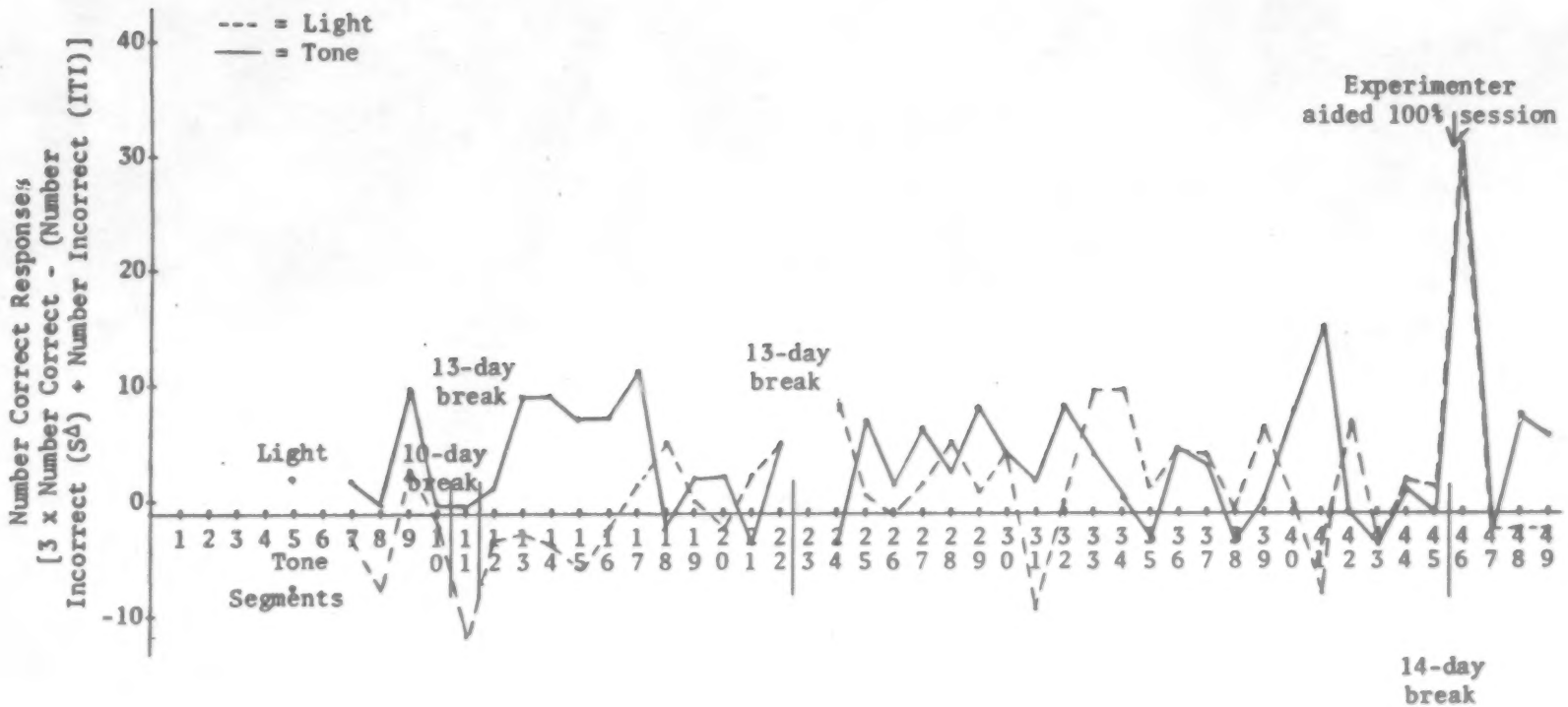

--- = Light
—— = Tone
Number Correct Responses
[3 x Number Correct - (Number Incorrect (SΔ) + Number Incorrect (ITI))]
40
30
20
10
0
-10
Light
13-day break
10-day break
13-day break
Experimenter aided 100% session
14-day break
Tone Segments
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Figure 13. Dude: Learning curve over segments.

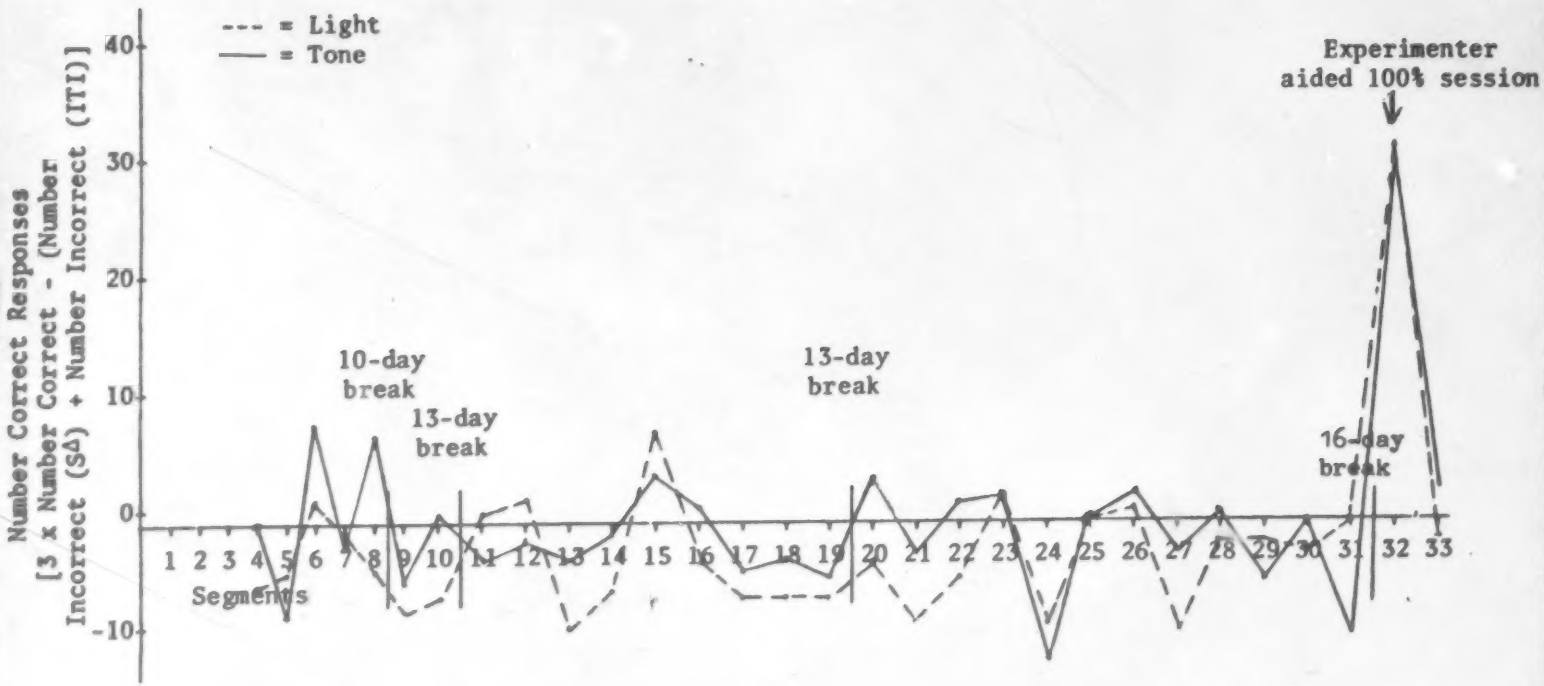

--- = Light
—— = Tone
Experimenter aided 100% session
Number Correct Responses
[3 x Number Correct - (Number Incorrect (SΔ) + Number Incorrect (ITI))]
40
30
20
10
0
-10
10-day break
13-day break
13-day break
16-day break
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
Segments

Figure 14. Tiffany: Learning curves over segments.

responding during the S^{Δ} and ITI. In this way each child received a score of 97% or greater on each discrimination. Figures 13 and 14 reveal that this procedure had little or no effect on subsequent performance. Testing was discontinued after Dude's 49th session and Tiffany's 33th session.

DISCUSSION

The results of Experiment 2 indicate that for the majority of the children, the stimuli which proved reinforcing in Experiment 1 readily acquired cueing value in Experiment 2. While the children did not show an overall difference in the number of segments required to learn the two discriminations, the children who evidenced a strong preference for light in Experiment 1 performed significantly better on the light discrimination over sessions than did the children who evidenced little or no stimulus preference. Thus preliminary evidence is established for a positive relationship between stimulus preference and rate of discrimination learning.

The children who were unable to meet criterion on either task (Dude and Tiffany) were those with the lowest mental ages of all children who participated in this experiment. Whether mental age was a causative factor in determining these particular outcomes can only be speculated but, this possibility is not unlikely. An alternative explanation might be the potency

of the available reinforcers, at least for one of these children (Tiffany). Tiffany repeatedly displayed indifference toward the reinforcers, playing with them or rubbing them against the table. Even though she was always given the opportunity to choose the food she wished to work for, she rarely ate any of the rewards that she earned. Barpressing for Tiffany was an incidental occurrence, interspersed among her self-stimulatory behaviors.

CHAPTER V

EXPERIMENT 3

INTRODUCTION

Experiment 3 was conducted in order to determine whether the findings obtained in Experiment 2 would generalize to more ecologically valid discrimination tasks. While Experiment 2 provided preliminary evidence for a positive relationship between stimulus preference and rate of discrimination learning, the discrimination tasks employed would not likely be found in a classroom setting. The purpose of Experiment 3 was to provide a similar learning situation to that in Experiment 2, but with school-related material as the object of discrimination. Colored lights were exchanged for pictures, and tones for recorded words. The objectives for Experiment 3 were to establish whether: (1) the learning set developed in Experiment 2 would transfer to the learning situation in Experiment 3; (2) superior performance would be observed on the visual task by those children who strongly preferred light; and (3) any qualitative difference exists between the acquisition of school-related and nonschool-related (e.g., lights and tones) material.

METHOD

The four children who successfully completed Experiment 2 acted as subjects for Experiment 3. The same experimental room and apparatus were used as those in Experiment 2. The testing procedure employed in Experiment 3 was identical to that in Experiment 2 with two exceptions: (1) type of stimuli, and (2) length of stimulus presentation.

The visual and auditory stimuli used in Experiment 3 were as follows: (1) visual. A black and white line drawing of a frog, and one of a tank (see the Appendix). These drawings were made into slides and presented in the form of negatives (i.e., with black backgrounds and white outlines of the figures) to avoid excessive brightness when projected on the screen; (2) auditory. The words "frog" and "tank" were recorded by a male experimenter onto cassette tapes and played through the speaker in the experimental room. Frog and tank were chosen for the following reasons: (a) they contained only one syllable and were therefore structurally simple; (b) they were phonetically different (vowels and consonants); and (c) the children were relatively unfamiliar with them. A visual Sd was assigned randomly to each child, and the auditory Sd consisted of the word not corresponding to that particular drawing. For example, if a child's visual Sd was frog, his/her auditory Sd automatically became tank. This procedure insured that prior familiarity

with the stimuli would not give the child an added advantage in this learning situation.

The stimuli were presented for 1.5 sec (instead of 5 sec) and presses occurring during the stimuli, or in the 3.5 sec immediately following the offset of the stimulus were counted as correct responses. The length of stimulus presentation was reduced because it was impossible to present either frog or tank aurally for a longer period of time than 1.5 sec without significantly distorting the word. The ITI was initiated either after the 3.5 sec had elapsed, or after a correct response had been made to the Sd.

RESULTS

The number of segments required by each child to reach criterion on the visual and auditory discriminations are presented in Table 6. The number of segments for the auditory discrimination were subtracted from the number for the visual discrimination, and a *t* test for the difference between correlated means was conducted on the data for the four children. A nonsignificant difference ($t(3) = 1.12$) was found between the means, indicating that the children learned the discriminations at approximately the same rate. A Mann-Whitney nonparametric *U* test was conducted to compare the two groups of children (i.e., Preference versus No Preference) on speed of acquisition of the tasks. This

TABLE 6

Number of Segments to Criterion, Differences, and Stimulus Preferences

Subjects	No. of Segments Visual	No. of Segments Auditory	Difference	Stimulus Preference	Strength
Jimmy	1	3	2	Light	Strong
Eric	2	2	0	Light	Strong
Erin	4	8	4	Light	Strong
Tony	3	2	-1	--	--

test was used due to the limited size of the "No Preference" group (one member). Although a trend was evident (i.e., superior performance on the visual discrimination by the Preference group), a nonsignificant difference was found ($U = 0$, $p = 0.25$).

The mean number of correct responses on both discriminations over sessions was calculated for each child and is presented in Table 7. A t test for the difference between correlated means was conducted on the data for the four children to determine differences in rate of acquisition of the two tasks. A significant difference ($t(3) = 4.39$, $p < 0.05$) was obtained, indicating overall superior performance on the visual discrimination by

TABLE 7

Mean Total Correct for Visual and Auditory Over Sessions, and Difference Between Means (Mean Light - Mean Tone)

Subjects	Mean Total Visual	Mean Total Auditory	Difference
Jimmy	30.75	23	7.75
Eric	27.5	21.5	6
Erin	21.87	19.86	1.99
Tony	27.75	22.25	5.5

all of the children. Examination of Figure 15 reveals that this difference was most evident on the first segment of each child's learning curve. The data for the children's first session are presented in Table 8. A t test for the difference between correlated means was performed on this first session data, and yielded a significant difference ($t(3) = 12.76$, $p < 0.01$) in the rate of performance on the tasks, in favor of the visual discrimination. These results suggest that at least initially, learning was superior on the visual task. A Mann-Whitney U test conducted on the data in Table 7 yielded no difference in the performance of the two "groups" ($U = 1$, $p = 0.5$).

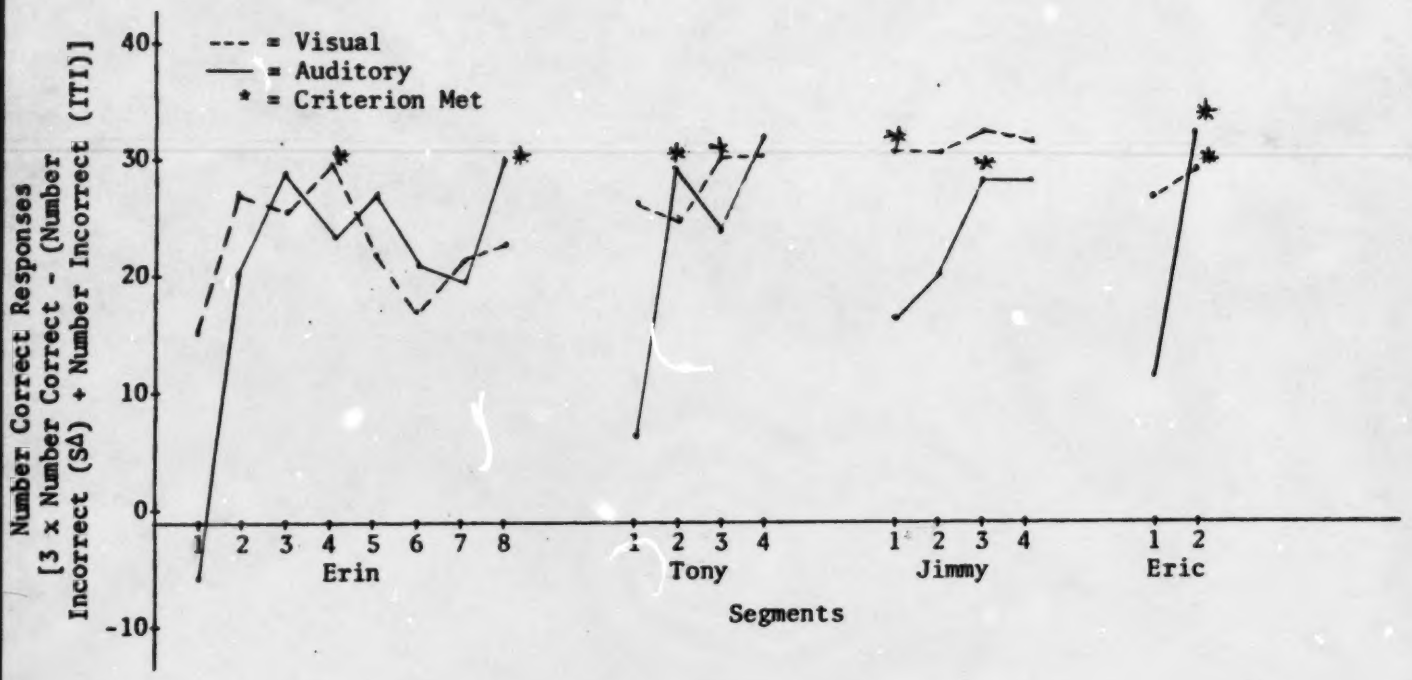


Figure 15. Learning curves for all children: Experiment 3.

TABLE 8

Total Correct for First Session Visual and Auditory, and Differences

Subject	Visual	Auditory	Difference
Jimmy	30	16	14
Eric	26	11	15
Erin	14	- 5	19
Tony	26	7	19

In order to determine whether a learning set transferred from Experiment 2 to Experiment 3, the number of segments required to complete the visual and auditory discriminations in each experiment were compared, and are presented in Table 9. t tests for the difference between correlated means (i.e., mean number of segments for visual in Experiment 2 - mean number for visual, Experiment 3; mean number of segments for auditory, Experiment 2 - mean number for auditory, Experiment 3) yielded a significant difference between the number of segments required to complete the visual discriminations ($t(3) = 8.84$, $p < 0.01$), and a significant difference in the number of segments required for the auditory discriminations ($t(3) = 3.56$, $p < 0.05$), with speedier performance

TABLE 9

Difference in Number of Segments to Reach Criterion on Visual and Auditory Discriminations in Experiments 2 and 3

	Visual			Auditory		
Subject	Experiment 2	Experiment 3	Difference	Experiment 2	Experiment 3	Difference
Jimmy	14	1	13	34	3	31
Eric	19	2	17	17	2	15
Erin	14	4	10	18	8	10
Tony	15	3	12	14	2	12

on both tasks evidenced in Experiment 3. Thus, tentative evidence for the transfer of a learning set was established.

Observational data obtained during the experiment yielded some interesting but not unexpected results. For example, the echolalic children (Tony and Erin) typically repeated the words after they were presented aurally. However, this echoing behavior did not interfere with the ability to make the appropriate discrimination. It should also be noted that Erin was reinforced inappropriately for pressing to the first presentation of the S^{Δ} visual stimulus in her fifth segment. This might account for the decline in her performance on the visual task after she reached criterion.

CHAPTER VI

GENERAL DISCUSSION

The purpose of the present experimental program was threefold: (1) to attempt to identify visual or auditory preferences in a group of autistic children, (2) to determine whether stimulus preference was related to rate of discrimination learning, and (3) to establish whether stimulus preferences would enhance the rate of acquisition of school-related material. Despite the numerous problems incurred in the implementation of these experiments, preliminary results indicate that those children who evidenced a strong preference for visual stimuli did in fact perform significantly better on a simple visual discrimination task than did children who evidenced a weak preference for light, or no preference for either type of stimulus. In other words, stimuli which proved to have a more potent reinforcing value seemed to acquire a cueing value more readily than stimuli which were less reinforcing. Thus this novel approach has promising implications for future assessment and prediction of performance on similar tasks.

The most notable problem associated with this series of experiments was the attrition rate of the subject group. In the initial assessment phase, 6 out of 13 children failed

to meet the requirements for successful completion of the task. As discussed earlier, these children were among the lower-functioning (i.e., MA less than 31 months) group, engaging in self-stimulatory and other behaviors incompatible with those requiring successful performance. It may be speculated that the stimuli available in this experiment had little reinforcing value for these children, an explanation which would be supported by the theory of near-receptor versus far-receptor dominance for low-functioning children (see Goldfarb, 1956; Schopler, 1965). This hypothesis might be tested in future research by including tactile stimuli when assessing preferences. With respect to present educational settings, this far-receptor avoidance might explicate difficulties observed in learning situations where the focus is mainly on the visual and auditory modalities. If it is found that lower-functioning children do indeed work for tactile stimuli, these might then be incorporated into teaching strategies to facilitate the transition from near- to far-receptor responsiveness.

Another possible approach to take with lower-functioning children would be to use stimuli which are representative of their own self-stimulatory behavior. Previous research in this area (see Frankel et al., 1976; Rincover et al., 1977) has indicated that lower-functioning children will work to receive environmental stimulation which is similar to the type of self-stimulatory behavior they most frequently emit. While

this work is in need of replication with larger numbers of children, it is possible that this method might provide a means of contact with children who are otherwise unresponsive. Admittedly, the stimuli used in this experiment were limited in complexity (i.e., colored lights, pure tones) for the ultimate purpose was to relate preference to speed of learning, and not to measure preference for a wide variety of stimuli. It might be suggested that future researchers attempt to look at preferences for a greater range of stimuli within the visual and auditory modalities.

The need to develop appropriate assessment techniques for stimulus preferences of lower-functioning children is made especially salient when we consider the performance of the higher-functioning children. Despite their extensive and varied learning experiences in school settings, the majority of higher-functioning children evidenced differential rates of learning as a function of their stimulus preferences. In Experiment 3, where school-related material was substituted into the discrimination task, all of the children initially performed significantly better on the visual than the auditory discrimination. It might be suggested, then, that for these children, an emphasis be placed on the provision of visual material in educational programs.

In addition to the issues discussed above, three major implications emerge from these results. The first is suggested when we look at the performance of one child, Jimmy. Jimmy is a child who is functionally mute, and scored low on the IQ

test presumably due to his lack of speech. In the case of a child who fails to develop language, errors may often be made in the assessment of the child's hearing ability. This is compounded by what has been observed to be idiosyncratic responding to different auditory input (see Ornitz & Ritvo, 1968). The assessment procedure used in Experiment 1 confirmed the fact that Jimmy is much more visually than auditorily oriented. The substantial difference in his rate of acquisition of the two discrimination tasks employed in Experiment 2 confirmed his difficulty with auditory input. However, his performance in Experiment 3 provides ample evidence that he is, in fact, responsive to verbal input. This assessment procedure, if implemented effectively, could provide diagnostic information regarding an autistic child's ability to differentiate auditory stimulation.

A second implication of this research pertains to the homogeneity of the autistic population in general. The idiosyncratic response patterns of a relatively small number of children (13) emphasizes the difficulties incurred when attempting to assign these children to groups. If, as was the case in the present research program, only a small number of children were able to complete what were relatively simple tasks, further attempts should be made to define the characteristics of children who were unable to meet the specific experimental requirements. It may ultimately be found that individual treatments have to

be designed for each particular child according to his/her specific characteristics. While this approach would undoubtedly prove more costly, the benefits for the children might be greatly enhanced. As a case in point, we can look at the performances of Dude and Tiffany in Experiment 2. Both of these children failed to meet criterion on either discrimination. Remedial strategies (i.e., experimenter aid) failed to ameliorate their level of performance. It is possible, though, that other strategies would have facilitated learning. For example, had each child been seated at a table across from the experimenter, and presented with two cards (i.e., one red and one yellow), and required to point to the correct card, it may have been possible to determine to what extent the discrimination had been learned. It is up to future researchers to implement what they feel are plausible remedial strategies.

The final implication concerns transfer of learning. The results of Experiment 3 suggest that the learning set established in Experiment 2 readily transferred to the learning situation in Experiment 3. The assertion may be made that the school-related task presented in Experiment 3 was easier than that in Experiment 2 (due to the children's familiarity with this type of material), however, because the order of presentation of the tasks was not randomized, this assertion cannot be verified from the present results. If we assume, though, that a learning

set can transfer between similar tasks, then a possible next step should be to determine to what extent learning will generalize to other types of tasks. This information would no doubt be of value to individuals concerned with educational programming for autistic children.

In summary, the results of this innovative research program have provided new information regarding stimulus preferences and rate of discrimination learning in autistic children. These tentative findings suggest that this area might be a promising one to pursue for individuals interested in developing alternative teaching strategies which allow for the idiosyncratic responding of autistic children to environmental stimulation.

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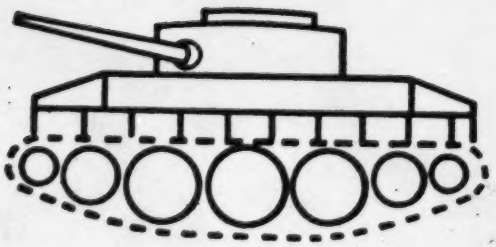
APPENDIX

APPENDIX



ABSTRACT

ABSTRACT

Over the past two decades several groups of researchers have purported that one of the primary factors in the etiology of early infantile autism is the inability to integrate and intelligently organize information present in the environment. Researchers who have focused on the learning characteristics of autistic children under varying conditions of sensory stimulation have claimed that autistic children evidence (1) an abnormal modality preference, (2) an inability to code information, or (3) overselective attention. Those who have focused on physiological activity in autistic children argue that these children are (1) underaroused, (2) overaroused, or (3) exhibit perceptual inconstancy. Though these proposed dysfunctions have stimulated much research aimed at identifying specific perceptual-cognitive deficits in autistic children, they have not, as of yet, led to the development of effective intervention strategies for these children. The present study was an attempt to expand on the available information regarding modality preference in autistic children and determine its relation to the effectiveness of various instructional techniques (i.e., utilizing modality strengths).

In Experiment 1, preferences for specific auditory (700 and 1300Hz pure tones) and visual (yellow and red lights) were

assessed in a group of seven autistic children. Each of the four combinations of tone and light pairs was made available during three of a total of 12 8-minute sessions. The children could obtain 5 sec of the available auditory stimulus by pressing one button, or obtain 5 sec of the visual stimulus by pressing the other button (both on FR-5 schedule). The total number of button presses for auditory and visual inputs was recorded for each session. Results indicated that three of the children showed a strong preference for the visual input (i.e., pressed at least twice as much for light as for tone, and exhibited a light preference in at least twice as many sessions as a tone preference), three showed a moderate (i.e., 1.5 to 1 for presses and sessions), or a weak (i.e., 1.3 to 1 for presses and sessions) preference for light, and one did not evidence a preference for either type of sensory input. The next task was to determine whether stimulus preference was related to the speed at which the children would learn a discrimination.

The visual and auditory stimuli used in Experiment 1 were incorporated into two simple serial discrimination tasks in Experiment 2, in which six of the seven children participated. One of the tasks required responding (i.e., barpressing for food) to one of the two lights, and the other, to one of the two tones. The discriminative stimuli chosen for each child were those that he/she least preferred in Experiment 1. The

children were exposed to the tasks until a 90% criterion of correct responding was achieved on both discriminations. Results indicated that children who evidenced a strong preference for light performed significantly better on the light discrimination over sessions than children who evidenced a weak preference for light or no preference for either type of stimuli. Thus, preliminary evidence was established for a positive relationship between stimulus preference and rate of discrimination learning.

In Experiment 3, four of the seven children were assessed for speed of acquisition of school-related material in similar discrimination tasks. Pictures of a "frog" and a "tank" were substituted for the colored lights and the recorded words "frog" and "tank" for the pure tones. The children performed significantly faster on both the visual and auditory discriminations in Experiment 3, indicating transfer of learning set. A significantly greater facility with the visual discrimination was noted among all children in the initial session. No difference was found in the rate of acquisition of the two tasks over sessions. Several implications for educators were discussed.